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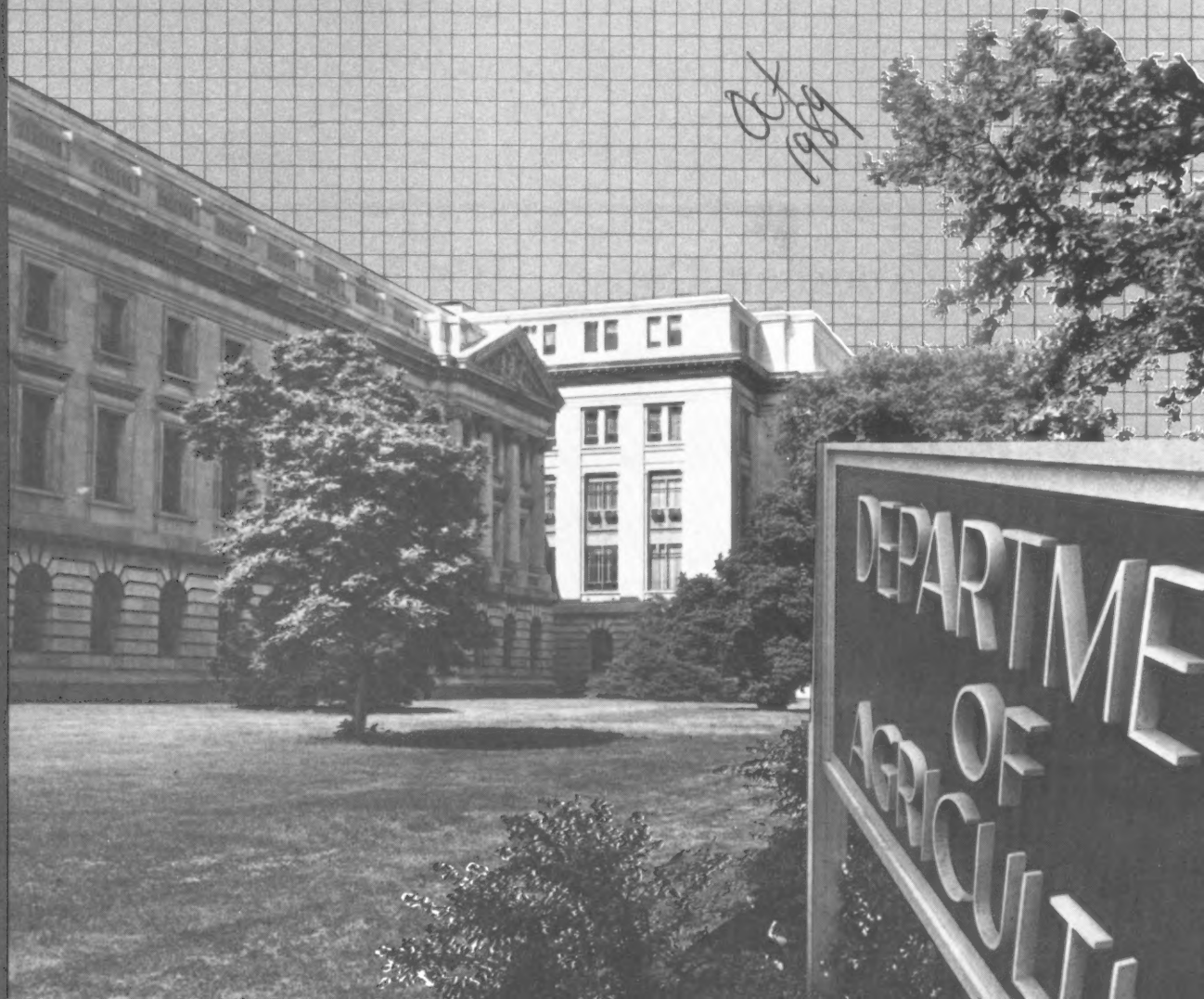
Major Statistical Series of the U.S. Department of Agriculture

Agricultural Production and Efficiency



Volumes in Handbook

Agriculture Handbook No. 671, *Major Statistical Series of the U.S. Department of Agriculture*, will consist of 12 volumes.

1. Agricultural Prices, Expenditures, Farm Employment, and Wages
2. Agricultural Production and Efficiency
3. Farm Income
4. Agricultural Marketing Costs and Charges
5. Consumption and Utilization of Agricultural Products
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Major Statistical Series of the U.S. Department of Agriculture: Volume No. 2: Agricultural Production and Efficiency. By James H. Hauver, Resources and Technology Division, Economic Research Service, U.S. Department of Agriculture. Agriculture Handbook No. 671.

Abstract

This volume describes how statistics on production inputs, production outputs, and productivity (output per unit of input) are constructed for the U.S. Department of Agriculture. It shows how national aggregates are subdivided and defines regional and commodity group activities. Meaningful analyses of productivity trends are made possible in this important field, both by region and among commodities. The U.S. Department of Agriculture is improving its productivity indexes by introducing a new Tornqvist national multifactor productivity index.

Keywords

Productivity, farm output, farm input, crop, region, livestock, labor, efficiency, machinery, fertilizer.

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Foreword

This set of 12 volumes on the *Major Statistical Series of the U.S. Department of Agriculture* (Agriculture Handbook No. 671) is the second revision that supersedes the original volumes published during 1957-60. The first revision was completed in 1972.

Our goal for this handbook remains essentially unchanged. We hope to help government, university, private sector, and other users become better acquainted with the concepts and data underlying the Department's statistical series. We believe this handbook will benefit new users as well as those already familiar with the Department's statistics. If you find it valuable in improving your knowledge of what the various data series measure and how appropriate they may be for specific uses, we will have largely succeeded.

The challenge for our statistics is to reflect events in the agricultural sector and rural areas as they are, insofar as possible, and in this way contribute to public understanding. Because much has changed in the economics of rural areas and the food and fiber system since the last revision, we have adopted some new procedures. Thus, although the revised handbook describes several established series essentially as they were in the two earlier handbooks, it also notes changes in ongoing series, describes new series, and identifies some series that are no longer published.

Your interest in the Department of Agriculture's statistical series is important. We welcome comments on either these handbook volumes or the series they describe.

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Glossary

The following organizational abbreviations appear in this publication:

AAEA	American Agricultural Economics Association
ARED	Agriculture and Rural Economy Division, ERS
ARS	Agricultural Research Service, USDA
ASB	Agricultural Statistics Board, NASS
ASCS	Agricultural Stabilization and Conservation Service, USDA
BAE	Bureau of Agricultural Economics, USDA (abolished 1953)
BLS	Bureau of Labor Statistics, U.S. Department of Labor
CED	Commodity Economics Division, ERS
CRB	Crop Reporting Board (former name for ASB)
ERS	Economic Research Service, USDA
FCRS	Farm Costs and Returns Survey
FIEI	Farm and Industrial Equipment Institute
FSFAB	Farm Sector Financial Analysis Branch, ARED
FTB	Financial and Tax Branch, ARED
ITPB	Inputs, Technology, and Productivity Branch, RTD
NASS	National Agricultural Statistics Service, USDA
RTD	Resources and Technology Division, ERS
SRS	Statistical Reporting Service (former name for NASS)
TVA	Tennessee Valley Authority
USDA	U.S. Department of Agriculture

Major Statistical Series of the U.S. Department of Agriculture

Volume 2: Agricultural Production and Efficiency

James H. Hauver

Introduction

Since 1900, the U.S. farm sector has provided the American consumer with an ever greater abundance of agricultural products. This increase in output has been accompanied by more economical use of inputs, resulting in an increase in agricultural productivity.

Increased agricultural productivity improves standards of living by providing more agricultural products at a lower real cost, releasing resources for other sectors of the economy, and making U.S. agriculture more competitive in international trade. Productivity growth also stimulates market competition, causing resources to be shifted to their most productive allocations.

Agricultural productivity research is important for three reasons. First, research improves the accuracy of productivity measures, so we can assess where we are. Second, research can identify the sources of productivity growth and the underlying causes of past productivity trends. Third, productivity research assists in the design of government policy to enhance agricultural productivity and foster greater economic growth and well-being. The U.S. Department of Agriculture (USDA) has published indexes of farm outputs, inputs, and productivity each year since 1960 to facilitate this research.

Agricultural Productivity: Concept and Measurement

Productivity measures the relationship between output (goods and services) and one or more inputs (labor, land, capital). Productivity is expressed most often as a ratio of outputs to inputs. An improvement in productivity means that more output can be obtained for a given input, or alternatively that the same level of output can be obtained with fewer inputs.

Economists use two approaches to measure productivity: partial and multifactor productivity measures. Partial productivity measures relate one or more outputs to one input. The yield of corn (bushels per acre of land) relates one output (corn) to a single input (land). When only a single output and a single input are concerned, then partial productivity measures are the average physical product of that input. The index of crop production per acre is an example of a multiple output/single input partial productivity measure. There can be at least as many partial productivity measures as there are outputs and inputs.

Partial productivity indexes, especially labor productivity measures are historically the oldest productivity measures and are still cited the most. They are easy to compute, the required data are readily available, labor remains a very important production factor for most sectors of the economy, and partial productivity indexes are easier to understand.

Partial productivity indexes are easy to compute but difficult to interpret. The reason is that other inputs have changed over time and are used in more efficient combinations. The dramatic improvement in agricultural labor productivity since World War II reflects not only technical improvements, but also increased use of other factors of production, such as capital and agricultural chemicals.

Labor has declined in importance as an input in agricultural production. Farm labor comprised 19.5 percent of total farm input use in 1986, compared with 68.2 percent in 1870. In contrast, labor productivity continues to be an important measure in the nonfarm sector.

Most economists now favor multifactor productivity (MFP) indexes. A multifactor productivity index relates outputs to a weighted sum of all inputs based on their relative importance in the production process. An example of a multicommodity output, multiresource input index is the USDA total farm output per unit input index.

The use of MFP indexes introduces a new problem: the aggregation of heterogeneous inputs and outputs. Price weights have usually been adopted for this purpose.

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No existing multifactor productivity index is completely comprehensive, in the sense of including literally all outputs and inputs. Data limitations, plus the absence of information about nonmarket transactions, prevent the development of true total factor productivity measures, but MFP indexes are far more comprehensive than partial productivity measures.

The USDA Productivity Series

The Economic Research Service (ERS) prepares and publishes several partial productivity measures. The total output index is divided by the labor input index to obtain a measure of labor productivity, the index of farm production per hour of labor. ERS also publishes a closely related labor productivity measure, the number of persons supplied farm products by one U.S. farmworker. The index of crop production per acre is a partial productivity index based on land, derived by dividing the index of crop production by cropland. Finally, a partial productivity measure for livestock breeding units is the index of livestock production per breeding unit.

USDA's most cited measure of productivity is the ERS multifactor productivity index, obtained by dividing the index of total farm output by the aggregate input index. The index of farm output measures annual changes in crop and livestock production available for human consumption. In addition to an overall farm output index, indexes for total crop and livestock production are constructed, together with indexes for 11 crop and 4 livestock commodity groups.

The index of total farm inputs measures annual changes in the volume of resources used in farm production. The general index of farm inputs is an aggregation of seven major categories of inputs. In addition to the general index of total farm inputs, separate indexes are prepared for each of the seven major input groups.

The output, input, and multifactor productivity index series are published each year for the United States and for 10 farm production regions (*42*).[1]

Historical Background

Before the Second World War, the only measures of total agricultural production were the production for sale and home consumption index series (*67*). The Crop Reporting Board (CRB) published estimates of production of individual commodities and total crop production. The production for sale and home consumption index series measured commodities entering the marketing process or used for home consumption. The indexes were more closely related to farm income than to changes in farm resources used in farm production during a given year.

Barton and Cooper constructed and published a total farm output and gross farm production index in 1945 (*3*). Both series counted production in the year it was produced, even if consumption occurred in later years. Farm output measured production available for eventual human consumption, while gross farm production included farm-produced power from horses and mules. Indexes were prepared for the nine census geographic regions and for the United States. In addition, Barton and Cooper developed indexes of net livestock and total crop production. They used the 1935-39 period for their reference period (1935-39 = 100). The CRB series for crop production continued to use 1923-32 = 100 as a reference period.

USDA discontinued publishing a separate gross farm production series in 1953, though the series continued to be available for research purposes. To avoid confusion, only the CRB crop production index was subsequently published in the current year, while the Barton-Cooper series for crop production was maintained as a historical series. The two series were made comparable by reweighting both to a 1947-49 base period. The livestock index was changed to a gross rather than net index. Durost (*10*) revised the Barton-Cooper output series in 1960, this time on the basis of 10 farm production regions, and reestimated the indexes back to 1939.

A series of input measures were also developed in the mid-1940's by Cooper, Barton, and Brodell (*6*) and Jennings (*21*). These series included hours worked, farmworkers, animal units of breeding livestock, cropland used for crops, power and machinery including and excluding horses and mules, and total inputs. Barton and Durost (*4*) published a revised input index for the United States in 1960.

Partial and multifactor productivity indexes were developed from the appropriate production and input indexes. These were prepared and published in the late 1940's by Barton and Cooper (*2*) and Cooper, Barton, and Brodell (*6*). However, these series were not consistently maintained in later years.

Loomis and Barton (*4*, *23*) redeveloped and published the U.S. total input series, which included all farm labor, farm real estate, and other inputs. A multifactor productivity index for the United States was estimated by dividing the total output index by the index of total inputs. Loomis and Barton used two base periods, 1935-39 and 1947-49, the latter for years after 1950. They prepared annual estimates for years beginning in 1910 and decade interval estimates from 1870 to 1900. Lambert (*22*) further revised Loomis and Barton's input series and published annual statistics in *Changes in Farm Production and Efficiency* (*42*), beginning in 1971. Lambert constructed his series by building up from the 10 production regions, using the 1947-49 base period prices from 1939 to 1954, and a 1957-59 base period from 1955 to date. Regional estimates were prepared for 1939 and subsequent years (*11*).

Construction of the Series

The USDA indexes of farm output, input, and productivity are defined in gross rather than value-added terms. A gross output series measures all the output, whether produced from resources originating within the farm sector or not. A total input series includes labor, land, other tangible capital, and

[1] Italicized numbers in parentheses refer to items in the References at the end of this volume.

nonfarm intermediate products. In contrast, a value-added output series would limit output to that produced with resources emanating within the farm sector alone. In this case, nonfarm intermediate resources would be excluded from measures of input. A total input series, based on the value-added concept, would be restricted to labor, land, and other tangible capital. The use of a gross rather than value-added approach distinguishes USDA's productivity series from those of other Federal agencies, such as the Bureau of Labor Statistics (BLS), which typically use the value-added approach in conformity with the National Income and Products Accounts (NIPA).

The USDA indexes for farm output, input, and productivity are Laspeyres quantity measures, constructed from the products of quantities and base period prices. Regional output and input indexes are first constructed and then expressed as a ratio to measure productivity for each region. The regional indexes are aggregated to derive national output and input indexes. The U.S. multifactor productivity index is the ratio of the national output index to the national input index, multiplied by 100.

The output and input index series are constructed in three broad operational steps. First, the quantities of each commodity, or input, produced in the current year are multiplied by a weighted average price for that commodity for some base period (1976-78). This calculation gives a quantity index which is analogous to a constant dollar value data series for each commodity relative to a specified base period. The regional quantity indexes are then summed to derive a national quantity index for each commodity. Because quantity data are not available for most inputs, current dollar expenditures are deflated by suitable price indexes to obtain constant-dollar quantity measures for these inputs.

Second, the quantity indexes are adjusted to a common base period, since different base period prices are used to aggregate inputs and outputs for different periods. For instance, production in the years 1939-55 uses average prices for 1947-49 as the base; production in the years 1955-65 uses average prices for 1957-59 as the base period. Establishing a common base period requires the use of splicing techniques.

Third, a Laspeyres quantity index is constructed by taking the quantity index for each period and dividing by the quantity index for a specified reference year. The present reference year is 1977, so production for that year is indexed to 100.

Productivity statistics have five important uses: pinpointing sources of economic growth; targeting the use of appropriated research funds; establishing production relationships between inputs, technological advances, and outputs; providing a measure of technical change; and comparing intersectoral performance.

Indexes of Farm Output

The index of farm output measures annual changes in the combined volume of crop and livestock production available for human consumption. The index measures output in the same year production occurs on the farm, although some of this production may be marketed in subsequent years. In addition to an overall farm output index, distinct indexes for total crop and livestock production are constructed, together with indexes for 11 crop and 4 livestock commodity groups. These commodity groups include feed crops, hay and forage, food grains, fruits and nuts, vegetables, oil crops, cotton, tobacco, sugar crops, seed crops, miscellaneous crops, meat animals, dairy animals, poultry and eggs, and miscellaneous livestock products. Production measures are prepared for each of 10 farm production regions, as well as for the United States, permitting an analysis of changes in the volume and composition of agricultural production at both regional and national levels, and their economic effect on farmers, farm suppliers, and consumers (table 1).

Construction of the Series

The farm output, livestock production, and crop production indexes are calculated annually for each of 10 farm production regions beginning in 1939, as well as for the United States from 1910 to date. Farm output estimates are calculated at decade intervals from 1870 to 1900. Weighted average prices received by farmers in a given region are used to construct the regional indexes. Beginning in 1939, the U.S. indexes are computed by adding the quantity-price aggregates for the 10 production regions.

Farm output is the combination of both total livestock and total crop production indexes after they have been adjusted to exclude the production of producer goods, which are goods produced on farms and used in further agricultural production. Producer goods include hatching eggs, feed fed to livestock, seeds, and, in earlier years, farm-produced power from horses and mules. Farm-produced power became an insignificant item and was dropped in 1965. Producer goods are excluded to avoid double counting; for instance, the crops fed to livestock counting for production of both livestock and crops. Likewise, care should be taken to avoid counting hatching eggs twice, as both poultry meat and egg production, or seed production as both an input and crop production. Because of these adjustments, the farm output index may be outside the range of the index number of either of its component parts. For instance, in 1984, the component indexes for crop and livestock production were 111 and 107, but the farm output index of that year was 112.

NASS reports are the principal sources for commodity and price information (*31, 35, 38, 48, 53, 54, 56, 58, 60*). Indexes of production are constructed on a calendar year basis. While basic production statistics for livestock are available by calendar year, crop statistics are often reported by crop year rather than calendar year. In such cases, the year of harvest is considered the year of production.

The indexes are computed by the familiar constant price-weight method, using average base period prices received by farmers for commodities produced. They are Laspeyres quantity indexes of the type widely used throughout the Federal Government. Analysts calculate the production index series in three steps.

Step 1: Quantities of each commodity produced each year are multiplied by weighted average prices received by farmers during the weight period to arrive at price-quantity aggregates, by region. The regional price-quantity aggregates are summed to derive a national price-quantity aggregate.

To reduce the effects of extreme weather or a similar event, average prices received by farmers for commodities produced during specified periods have been used as price weights. Different weight periods are used for different years to reflect changes in the composition of production. Regional indexes use four weight periods, while the U.S. indexes have five weight periods. For 1975 and subsequent years, the relevant weights are average 1976-78 prices received by farmers in each farm production region (*31*). Similarly, average 1967-69 prices are used for the period 1965-75, average 1957-59 prices are used for 1955-65, and average 1947-49 prices are used for 1939-55. Average 1935-39 prices are used for the U.S. indexes for 1939 and prior years and also for the 1870-1900 decade intervals.

Once the appropriate price weights have been determined, currently 1976-78, they are multiplied by the quantities of each commodity produced each year. Appendix I lists all commodities included in the output index. The resulting regional price-quantity aggregates sum to comprise the national price-quantity aggregate.

Step 2: Since different price weights are used for different time periods, the price-quantity aggregates are spliced together to obtain a single time series with a common price base.

The use of five weight periods makes splicing of price-quantity aggregates necessary to provide a continuous time series related to the most recent price weight period. Accomplishing the splice requires that two price-quantity aggregates be calculated for selected splice years (1975, 1965, 1955, and 1939), one using the later price weights and the other using the earlier price weights. For example, price-quantity aggregates for 1975 are computed in terms of both 1976-78 and 1967-69 prices.

Splicing is accomplished by first computing ratios of price-quantity aggregates for the most recent splice year overlap. For example, the 1976-78 price-quantity aggregates for 1975 are expressed as ratios to the 1967-69 price-quantity aggregates for that year. The price weights differ, but the quantities are the same. The resulting ratios (by region) are applied to earlier price-quantity aggregates for 1965-74, originally calculated using the 1967-69 price weights. The same method is applied to all splice years and weight periods. Because the spliced price-quantity aggregates now

Table 1—Indexes of U.S. farm output by enterprise group

Year	Total farm output	Livestock and livestock products				Crops									
		All	Meat animals	Dairy products	Poultry and eggs	All	Feed grains	Hay and forage	Food grains	Vegetables	Fruit and nuts	Sugar crops	Cotton	Tobacco	Oil crops
						Index, 1977=100									
1950	61	70	70	88	50	59	51	72	49	82	71	55	72	107	26
1960	76	82	80	95	68	72	69	83	66	88	69	60	102	102	38
1970	84	99	102	95	93	77	71	92	69	96	81	95	72	100	66
1980	104	108	107	105	115	101	97	98	121	104	119	97	79	93	99
1981	118	109	106	108	119	117	121	106	144	111	111	107	108	108	114
1982	116	107	101	110	119	117	122	109	138	116	113	96	85	104	121
1983	96	109	104	114	120	88	67	100	117	107	110	93	55	75	91
1984	112	107	101	110	123	111	116	107	129	117	114	95	91	90	106
1985	118	110	102	117	128	118	134	106	121	122	119	97	94	81	117
1986	111	110	100	117	133	109	123	106	107	117	112	106	69	63	110
1987[1]	110	113	102	116	144	106	105	103	106	122	121	112	104	64	106

[1]Preliminary.

have the same price base overall, the series is comparable over time, but the method permits the preservation of the relative commodity structure of earlier weight periods. The splicing technique is independently carried out for farm output, total livestock and crop aggregations, as well as for each commodity group, by region. Spliced regional price-quantity aggregates are summed to comprise the spliced U.S. price-quantity aggregate.

Step 3: Indexes are calculated relative to a reference period, currently 1977, by taking the ratio of the spliced price-quantity aggregate of the current year to the spliced price-quantity aggregate of the reference year (1977), and multiplying by 100.

Indexes of farm production are expressed in relation to a reference year. In 1986, the resulting index of total farm output was 111 (1977 = 100, table 1). In this manner, farm production indexes are annually computed for total farm output, total livestock, total crops, and for each of 15 commodity groups, by region and for the United States as a whole.

ERS will construct new price weights for its Laspeyres quantity index of outputs in 1990, using 1986-88 for the new base period. The new reference year will be 1987. The commodity composition of its output index may change to reflect new production and demand patterns. The adoption of new base period prices will necessitate resplicing the time series to reflect the new base period (1986-88), using 1985 as the new splice year.

The current year's indexes of farm output, crop production, and livestock production are based on preliminary and sometimes incomplete data. The current year's indexes are consequently subject to revision in the following year when more complete data become available. Revisions are normally made for the preceding year only, but on occasion for several years, when revisions are substantial.

The time series are subject to a much more radical revision, approximately every 10 years following a Census of Agriculture. New standard reference periods are adopted at this time to ensure that the indexes reflect the current structure of the economy. New price weights are developed and the compositional structure of production is modified by adding and deleting commodities to reflect their relative importance in the new weight period.

The farm production indexes are published each year by ERS in *Economic Indicators of the Farm Sector: Production and Efficiency Statistics* (*42*) and in April and September through December in *Agricultural Outlook* (*29*).

Forecasts of the index of crop production and selected component indexes for the current year are published monthly by NASS in *Crop Production* reports (*39*) from August through November. The indexes are updated and published again in the *Crop Production Annual* summary report (*38*) in January of the next year.

Limitations of the Series

The indexes of farm output and the component indexes of crop and livestock production cannot adequately measure changes in quality of products over time. These indexes reflect the changes in overall production caused by changes in quantities produced of individual items. This failure of the series to measure quality change is inherent with Laspeyres indexes.

Since the chief sources of data for production and prices are official reports from the Agricultural Statistics Board, production indexes are not fully comprehensive and omit some minor crops, some miscellaneous livestock products, and production from farm forests. However, these omitted items are insignificant parts of total farm output.

Farm output includes livestock and crop production, net of producer goods. Net livestock production includes neither feed fed nor hatching eggs, but pasture is not deducted. Thus, the value of pasture consumed by livestock is included in net livestock production. The index of crop production does not include pasture consumed by livestock. Therefore, the crop production index cannot be used as an indicator of crop production from all farmland, but as an indicator of crop production on all cropland used only for crops. With this treatment, pasture does not need explicit evaluation but is included in the farm output index.

Production Inputs

ERS publishes five general indexes of production inputs each year. These include the index of total farm inputs; required hours of farmwork, by enterprise; numbers of farm machines; consumption of fertilizers and lime; and indexes of animal units of breeding livestock. The required hours of farmwork time series was discontinued in 1987 due to the availability of new survey-based labor use estimates (see below).

Index of Total Farm Inputs

The index of total farm inputs measures annual changes in the volume of resources used in farm production. As a multifactor index, the series includes all resources committed to agricultural use by farmers, but excludes farm-produced goods also used as inputs in farm production. The main use for an index of farm inputs is to furnish the denominator for the ratio of farm outputs to farm inputs, which is the index of overall agricultural productivity.

The series developed from a need for a comprehensive measure of productivity. Before World War II, partial productivity measures, especially labor productivity, were judged to be satisfactory given available data. But labor productivity became a less useful measure as capital assumed a more important role in the farm sector's increased productivity. Loomis and Barton developed the first comprehensive measurement of total inputs used in U.S. agriculture to fill the need for a more accurate measurement of agricultural productivity. These estimates were published in April 1961 (*23*). Loomis and Barton extended the series for each year back to 1910, and with decade-interval estimates, back to 1870.

The indexes of farm input use are now calculated each year for 10 farm production regions beginning in 1939, and are available for the United States each year from 1910 to date and at decade intervals from 1870 to 1900. While the general methods followed in constructing input and output indexes are similar, input indexes are not determined by enterprise group.

The general index of farm inputs is an aggregation of seven major categories of inputs, including: farm labor; farm real estate; mechanical power and machinery; agricultural chemicals; feed, seed, and livestock purchases; taxes and interest; and miscellaneous inputs (table 2). Separate indexes are prepared for each of the seven major input groups in addition to the general index of total farm inputs. These indexes are reported on a national and regional basis.

Farm inputs are also aggregated into purchased and nonpurchased groups, by region and for the United States as a whole. Indexes for these groups measure the year-to-year changes in the volume of purchased and nonpurchased resources used in agricultural production. Nonpurchased inputs include unpaid farm operator and family labor, depreciation of capital items, and a charge for the opportunity cost of funds invested in real estate, machinery, inventories of livestock and crops, and operating capital.

Purchased inputs include all other goods and services used in production, such as hired labor, fertilizer and liming materials, accidental damage and cost of repairs to service buildings, repairs and insurance for tractors, fuel and oil, dairy supplies, and numerous other items.

Since USDA measures farm sector productivity in gross rather than value-added terms, both input and output must be measured in a manner consistent with this approach. A gross output series measures all the output, whether produced from resources originating within the farm sector or not. A total input series includes labor, land, other tangible capital, and nonfarm intermediate products.

In contrast, a value-added output series would limit output to that produced with resources emanating from within the farm sector alone. Nonfarm intermediate resources would be excluded from measures of input in this case. A total input series, based on the value-added concept, would then be restricted to labor, land, and other tangible capital.

As gross measures, inputs include all resources used by farmers, whether originating inside or outside the farm sector. Except for the farm value portion of feed, seed, and livestock purchases, farm production expenditures estimated by ERS provide the underlying basis for constructing the input indexes. These inputs are classified as labor, tangible capital, and nonfarm intermediate goods and services. The farm input series also includes unpaid farm operator and family labor and a charge for the use of farmers' equity in capital investments. Capital inputs from public investment, such as expenditures for education, research, and health are not included.

Inputs exclude farm-produced goods and services used as inputs in further farm production (producer goods) to avoid double counting. Input measures are constructed with agriculture considered as one large farm, either for the United States or for each of the 10 farm production regions. Feed, seed, and livestock purchases are primarily farm outputs but are also used as farm inputs. As intermediate products within the agricultural sector, they are not counted as either output or input for purposes of productivity measurement. However, those components of feed, seed, and livestock purchases resulting from resources committed in the nonfarm sector are properly counted as inputs to agricultural production. The cost of processing, transporting, and marketing these items is computed by taking the difference between the "farmgate" price, which the farmer receives from the processor, and the retail price, which the farmer pays the dealer.

Construction of the Series

The input indexes are calculated by the weighted aggregate method in a manner very similar to output indexes using a Laspeyres arithmetic formula. When possible, quantities of each input used during the year are multiplied by weighted average prices paid during the weight base period. Quantities are available for labor, fertilizer, baby chicks and

Table 2—Indexes of total U.S. farm inputs and major input subgroup

Year	Total farm inputs			Farm labor	Farm real estate	Mechanical power and machinery	Agricultural chemicals	Feed, seed, and livestock purchases	Taxes and interest	Miscellaneous
	All	Non-purchased	Purchased							
					Index, 1977=100					
1950	106	167	64	265	109	72	19	58	83	63
1960	99	130	76	177	103	83	32	77	95	77
1970	96	106	87	112	105	85	75	96	102	89
1980	103	100	106	96	103	101	123	114	100	96
1981	102	98	106	96	104	98	129	108	99	108
1982	99	96	102	93	102	92	118	108	92	116
1983	97	92	102	97	101	88	105	110	97	101
1984	95	90	100	92	97	84	121	106	88	110
1985	92	85	99	85	95	80	123	106	91	116
1986	87	83	92	80	93	75	111	103	93	109
1987[2]	86	81	92	78	92	72	111	108	92	119

[1]Includes nonfarm value of feed, seed, and livestock purchases.
[2]Preliminary.

turkeys, and inventories of crops and livestock on farms. When quantities are not available, as is the case for most farm expenditure categories, current-dollar values are deflated by appropriate indexes of prices paid.

Calculation of the input index series proceeds in three steps. First, quantities of each input used each year are multiplied by weighted average prices paid by farmers during the weight period to arrive at price-quantity aggregates, by region. When quantities are not directly reported, reported current-dollar expenditures are deflated by appropriate price deflators to derive constant-dollar quantities of inputs. The regional price-quantity aggregates are summed to derive a national price-quantity aggregate. Appendix II lists all inputs included in the ERS input index. Appendix III lists price deflators used to estimate constant-dollar input values, when direct measures of quantities are unavailable.

Different weight periods are used for different years to reflect changes in the production process; for instance, the mechanization of agriculture and greater use of fertilizers over the last several decades. Regional indexes use four weight periods, while the U.S. indexes have five weight periods. Average 1935–39 prices paid by farmers are used as weights for the U.S. indexes for 1939 and earlier years including the 1870–1900 decade intervals, average 1947–49 prices for the U.S. and regional indexes for 1939–55, average 1957–59 prices for 1955–65, average 1967–69 prices for 1965–75, and average 1976–78 prices for 1975 and later years.

Second, since different price weights are used for different time periods, the price-quantity aggregates are spliced together to obtain a single time series with a common price base. Third, indexes are calculated relative to a reference period, currently 1977, by taking the ratio of the spliced price-quantity aggregate of the current year to the spliced price-quantity aggregate of the reference year (1977), and multiplied by 100.

ERS will develop new price weights for its input index in 1990, using average prices paid over 1986–88. The new reference year will be 1987. The composition of the input index will change when reweighing occurs, to reflect new conditions of production. The adoption of new base period prices will require resplicing of the entire input index time series, using 1985 as the new splice year.

ERS productivity analysts derive quantities for most inputs by deflating estimated current expenditures. ERS analysts use the benchmark-mover system to estimate annual farm production expenditures. Benchmark data collected periodically are used directly when available, and are the basis for estimates in years when these data are not available. The major source of benchmark data for the ERS accounts is the census of agriculture conducted every 5 years. ERS analysts use benchmark movers, which are data sources available each year, to calculate account estimates for nonbenchmark years. The Farm Costs and Returns Survey (FCRS), the primary benchmark mover used by ERS, can provide annual national production expenditures for many accounts.

Regional distributions of production expenditures observed during census years are used to allocate national expenditures by region during noncensus years. However, NASS surveys most farm production or output each year and the data do not require interpolation. In effect, production and value of production are observed every year on a State and regional basis, but regional production expenditures are interpolated, based on distributions during census years.

The ERS productivity analysts of the Inputs, Technology, and Productivity Branch (ITPB) obtain current input expenditure estimates from the Farm Sector Financial Analysis Branch (FSFAB) of ERS. FSFAB methods of estimating annual current expenditures are described in detail in two volumes of this handbook: Volume 3, *Farm Income* and Volume 11, *The Balance Sheet.* Productivity analysts

deflate current expenditures, using numerous price deflators (listed in Appendix III), developed by ITPB, FSFAB, NASS, BLS, and other Federal agencies.

In 1986, the resulting index of total farm inputs was 87 (1977 = 100). Farm input indexes are computed for total farm inputs, seven input categories, and purchased and nonpurchased inputs. Indexes are calculated for 10 farm production regions and for the United States.

The current year's input indexes are preliminary, since they are based on incomplete data. They are subject to revision in the following year when more complete data become available. Revisions are normally made for the preceding year only, but may occasionally go back several years if new information warrants.

The time series is subject to a more radical revision, approximately every 10 years, usually following a census of agriculture. New standard reference periods are adopted to ensure that the indexes reflect the current structure of the economy. New price weights are developed and the compositional structure of the production process is modified to reflect the appearance or disappearance of farm inputs and marked quality changes. Changed price weights modify the relative importance of inputs in the new weight period. The farm input indexes are published each year by ERS in *Economic Indicators of the Farm Sector: Production and Efficiency Statistics* (*42*) and in April and September through December in *Agricultural Outlook* (*29*).

Composition of Total Farm Inputs

Seven major input categories constitute total farm inputs: farm labor; farm real estate; mechanical power and machinery; agricultural chemicals; feed, seed, and livestock purchases; taxes and interest; and miscellaneous inputs. Miscellaneous includes expenditures for containers; fire, wind, and crop-hail insurance; greenhouse and nursery supplies; binding materials; irrigation operation and maintenance; sorgo and sugarcane tolls; veterinary services; dairy supplies; business-related telephone charges; and ginning charges. Appendix II lists of all inputs included in the input index.

Farm Labor

Farm labor includes the estimated total hours of hired and unpaid operator and family labor used in agricultural production. The total hours are weighted by composite hourly hired wage rates.

The labor series are survey-based estimates of labor, derived from two sources. U.S. and regional hours for 1984 and subsequent years are based on information from the ERS Farm Costs and Returns Survey (FCRS), which was first conducted in 1984. The FCRS provides labor use data at the national and regional levels by type of labor, specifically farm operator, unpaid family, and hired labor. The BLS labor series (*65*), which is based on the Census Bureau's Current Population Survey (CPS), was used to estimate labor use for 1947–83. The BLS series is available by type of labor, but only at the national level. ERS disaggregated the BLS series by region for 1947–83 by applying the percentage distributions used by ERS in its earlier labor series. These percentages are based on the relationship between each regional estimate by labor type and estimates at the national level. By aggregating the three labor types above, regional labor inputs were calculated (table 3).

The new survey-based labor series was incorporated into the ERS productivity measures in the 1985 *Production and Efficiency Statistics* report (*42*) as part of the process of implementing the recommendations of the American Agricultural Economics Association (AAEA) Task Force on Measuring Agricultural Productivity (*52*). ERS previously estimated labor use from labor requirements per acre or per unit of output. The labor hours reported in the earlier series were based on an assumed level of efficiency and therefore did not necessarily reflect actual efficiency changes.

ERS uses the new survey-based labor series to estimate total hours of farmwork used, indexes of total hours of farmwork used, and indexes of farm production per hour of total hours of farmwork used. The new labor series also serves as the labor component for indexes of total farm input and the multifactor index of farm productivity. These estimates are prepared on regional and national levels.

Unlike the earlier labor requirements series, the new labor series does not provide the necessary crop-specific information for estimating of labor use by enterprise group. ERS consequently continued temporarily to publish separate estimates of labor required by enterprise groups, based on the earlier series. However, the earlier labor series, discussed in a later section of this volume, was discontinued with the 1987 *Production and Efficiency Statistics* report (*42*).

The new survey-based regional estimates of labor quantities are multiplied by the 1976–78 base period average wage rate for hired labor, as published by ASB in Farm Labor (*43*), to derive price-quantity aggregates. The U.S. average wage rate per hour for hired farm labor for 1976–78 is used to aggregate the labor input index with other inputs.

Farm Real Estate

The farm real estate input index contains three components designed to measure service flows, which are an interest charge for the use of land and service buildings, depreciation of farm service buildings, and a miscellaneous remainder composed of estimated accidental damage, cost of repairs to service buildings, and grazing fees. Farm family dwellings are excluded.

To obtain a constant-quality land series, ERS divides farmland into three broad classes: acres of cropland, pasture, and other. Acres of irrigated and nonirrigated land are treated separately in 17 Western States. The census of agriculture provides benchmark estimates of acreage by class of land. NASS annually estimates total land in farms using data from the June Enumerative Survey (JES). Percentages in each land use category

Table 3—Indexes of total hours of farmwork

Year	Region										
	Northeast	Lake States	Corn Belt	Northern Plains	Appalachian	Southeast	Delta States	Southern Plains	Mountain	Pacific	United States
	Index, 1977-100										
1950	349	294	310	210	343	274	413	287	230	153	280
1960	219	202	209	141	211	162	225	181	163	122	181
1970	128	121	122	105	114	109	123	113	113	94	113
1980	93	92	94	96	96	101	92	90	97	102	96
1981	89	88	92	97	99	98	95	94	100	102	96
1982	88	86	91	94	95	90	90	87	96	104	93
1983	93	87	95	96	98	97	94	91	104	112	97
1984	143	141	109	95	74	47	73	100	102	63	92
1985	136	132	96	81	69	45	61	87	100	66	85
1986	127	115	102	77	60	47	54	73	82	71	80
1987[1]	107	117	97	73	62	49	57	68	96	63	78

[1]Preliminary.

are interpolated, based on JES data, between each census of agriculture.

ERS multiplies the estimated stocks of land each year by the 1976–78 price weights, the per acre values of farmland and service buildings, to derive constant-dollar values of land and service buildings for the current year. These computations are first made by land category (for example, cropland) and then summed to derive State, regional, and national price-quantity aggregates. The weight period land and service building values come from the census of agriculture.

The 1976–78 price weights were calculated in five steps. First, the current-year values of land were obtained for 1976–78 from the 1979 Farm Finance Survey (FFS), directly for 1978, and by interpolation for 1976 and 1977. Second, an estimated current-dollar value of service buildings, excluding dwellings, was added to land values to obtain an estimate of the current-dollar value of land plus service buildings for each of these 3 years. Estimates of building values were based on an estimated ratio of building value to land value, which are derived from the 1979 FFS. Since family dwellings are not counted as a production item, the estimated proportion of all buildings accounted for by dwellings was subtracted. FSFAB formerly updated these ratios each year, but ceased doing so after completion of the 1979 FFS, because information on the value of dwellings has not been subsequently collected. In 1979, the building/land ratio was 0.16 and the dwelling/buildings ratio was 0.58. A new survey, the Agricultural Economics and Land Ownership Survey (AELOS) conducted in 1989, will provide new benchmarks.

In the third step, ITPB analysts summed the values of farmland and service buildings over the 3 years, 1976–78, to comprise a multiyear price-quantity aggregate. Fourth, estimates of acreage were summed over the 3-year period. Three-year sums now existed for acreage and the values of farmland and service buildings, on a State, regional, and national basis.

In the fifth and final step, the 3-year summation of farmland and service building values was divided by the 3-year summation of acreage to derive base period price weights for 1976–78. Price weights were computed on a State, regional, and national level.

Each year, ERS multiplies the updated acreage estimates by the base period price weights (1976–78) to obtain constant-dollar values of current-year farmland and service buildings.

A stock/flow conversion is applied to obtain the service flow of real estate inputs. The conversion is done differently for the equity and debt portions of real estate value. For the equity portion, the ratio of net cash rent (excluding the landlord's share of expenses) to current value is multiplied by the current period's constant-dollar value of real estate. The current value of the equity portion is estimated by subtracting the value of outstanding mortgages from the total value of farm real estate. The value of outstanding mortgages is estimated by first computing the ratio of the current-dollar mortgage debt to the current value of farmland and service buildings. This ratio is applied to the current year's constant-dollar value of farmland and service buildings to derive the mortgaged portion. The residual comprises the equity portion of the total value of farmland and service buildings. The current-dollar values of farmland and buildings, and of mortgage debt are provided by FSFAB in ERS. Volume 11 of this handbook, *The Balance Sheet*, discusses current FSFAB methods in estimating these financial indicators.

The above method required modification when the new 1976-78 price weights were adopted. The loss of important data in the 1978 Census of Agriculture and followup 1979 FFS prevented ERS from estimating the equity capitalization rates by the earlier method. Because the only rent concept

available from the 1979 FFS was rent per acre for entire farms rented for cash, not excluding farm dwellings, the corresponding average value per acre was computed with all buildings included. Farm family dwellings could not be separately identified and excluded from calculations of net rent and farm value.

The new equity capitalization method extrapolated the new 1976-78 price weights from the 1967-69 weights by applying a ratio of the relative change of average rents to values per acre between the 1967-69 and 1976-78 weight periods to the earlier 1967-69 ratio of net rent to value. The ratio of relative change related the increase in total rent paid to the increase in total value, both including family dwellings. By applying this ratio of relative change to the old 1967-69 rates to extrapolate the 1976-78 rates, ERS assumed that rents (net and gross) and values (including and excluding family dwellings) had changed proportionately.

For the debt portion of real estate values, the constant-dollar value of mortgaged farmland and service buildings is multiplied by the 1976-78 average mortgage interest rate to obtain an estimate of the annual flow of services. The current year's estimate of farm real estate debt, supplied by FSFAB, is deflated by the ASB price index of production, interest, taxes, and wage rates (parity index) to obtain a constant-dollar real estate debt estimate. The 1976-78 weight period mortgage rates were computed on a regional basis as a weighted average of mortgage rates reported by Federal land banks, the Farmers Home Administration, life insurance companies, banks and trust companies, and miscellaneous financial institutions. These rates were provided by FSFAB.

Depreciation is calculated for service buildings as 2 percent of the constant-dollar value and added as a service flow. The constant-dollar value of service buildings is calculated by first computing the ratio of the regional current-dollar values of all buildings to the regional current-dollar value of land and buildings. This ratio, reestimated every year, is then applied to the current year's constant-dollar value of farmland and service buildings to derive the constant-dollar value of service buildings. The 2-percent depreciation rate is lower than that used in the farm income estimates of ERS, since ITPB analysts felt that estimates of depreciation plus repairs on buildings were too large, due to overreporting of maintenance expenditures. A lower depreciation rate compensated for any resulting measurement error.

Other items in farm real estate, including accidental damage to service buildings, repairs on service buildings, and grazing fees, are estimated from current expenditure data provided by FSFAB, based on the FCRS. Expenditures for each of these items are deflated by an appropriate index. Accidental damage not covered by insurance is deflated by the FSFAB index of service building construction costs. The FSFAB index of service building construction costs is the weighted sum of two ASB indexes, the farm wage rate index and the index of building and fencing material. Building repairs are deflated by the ASB index of building and fencing material and grazing fees are deflated by the ASB index of prices paid for production items. All expenditures are deflated to 1976-78 base period price levels.

Service Flows from Machinery and Mechanical Power

Farm machinery is a variety of capital stock that generates a flow of services over time. These service flows are an input in the production of farm output. Service flows from machinery and mechanical power include depreciation; an interest charge on the inventory value of automobiles, trucks, tractors, and other farm machinery; repairs, parts, tires, licenses and insurance for automobiles, tractors and trucks; and other machinery expenses, such as fuel and oil, electricity, custom work, small handtools, blacksmithing, and hardware. Only the production portion (farm share) attributable to total automobile and truck expenditures is counted as a service flow in input use.

The computation of depreciation and interest charges initially requires estimating the constant-dollar value of current inventories of machinery and equipment. FSFAB estimates the constant-dollar values of each machinery class, using the perpetual inventory method described in Volume 11 of this handbook, *The Balance Sheet*. Current ending stocks are equal to the last period's ending stocks, plus capital expenditures, less accidental damage, value of losses, and depreciation. All inventory values are in constant dollars. FSFAB analysts convert inventory values to a current-dollar basis by applying the ASB index of prices paid by farmers for farm machinery and motor vehicles.

ITPB analysts deflate current-dollar stock values by appropriate price indexes, provided by FSFAB and ASB. The value of automobile stocks is deflated by the FSFAB index of prices paid for automobiles, trucks by the FSFAB index of prices paid for trucks, tractors by the FSFAB index of prices paid for tractors, and other machinery by the ASB of prices paid for farm machinery.

The service flows from depreciation and interest charges can be estimated once constant-dollar stock values have been determined. FSFAB provides the depreciation estimates. These estimates are based on a declining-balance method in which a constant percentage representing the annual rate of depreciation for each type of capital is applied to its estimated value at the beginning of each year (*66*). The depreciation percentage for automobiles is 22 percent; trucks, 21 percent; tractors, 12 percent; and other machinery, 14 percent. Because automobiles and trucks are used for purposes other than farm production, their stock values must be adjusted to obtain the appropriate farm input index. The values of automobiles and trucks are divided between farm and household use based on estimates from the FCRS. In 1986, the farm sector balance sheet attributed 85 percent of the value of trucks and 45 percent of the value of automobiles to farm use.

Whether a farm operator pays cash for various machinery items used in farm production or purchases them on credit, capital is invested. When furnishing the capital, the farm

operator is forgoing the opportunity of earning interest on that capital invested in other endeavors. Thus, the opportunity cost of funds invested in capital equipment is included as an input. This flow is estimated by multiplying the farm share of the deflated capital stock value by the 1976-78 interest rate on farm real estate debt.

Other machinery expenses are estimated by deflating current expenditures. Current-dollar expenditures for repairs, parts, tires, licenses, and insurance for automobiles, tractors, and trucks are provided by the FSFAB, based on data from the FCRS. Current-dollar expenditures are deflated by composite indexes of prices paid. For automobiles, the composite index of automobile repairs, parts, tires, licenses, and insurance (ITPB) is the weighted total of three indexes of prices paid: the index of prices paid for automobile repairs and maintenance (BLS), the index of prices paid for automobile tires (BLS), and the index of prices paid, interest, taxes, and wage rates or parity index (ASB).

For tractors, the composite index of tractor and other farm machinery repairs, parts, and tires (ITPB) consists of the weighted sum of three indexes: the index of prices paid for automobile repairs and maintenance (BLS), the index of tractor tire prices (BLS), and the index of prices paid for automobile tires (BLS).

For trucks, the composite index of truck repairs, parts, tires, licenses, and insurance (ITPB) is the weighted total of three indexes: the index of prices paid for automobile repairs and maintenance (BLS), the truck and bus tire price index (BLS), and the index of prices paid, interest, taxes, and wage rates or parity index (ASB).

Finally, the mechanical power and machinery input includes expenditures on fuel and oil, electricity, custom work, small handtools, and blacksmithing and hardware, as reported by FSFAB from FCRS data. Current-dollar expenditures are deflated by appropriate price indexes from BLS and ASB: fuel and oil expenditures, by the gasoline price index (BLS), electricity expenditures, by the producer price index for electricity (BLS), custom work, by the index of farm services and cash rents (ASB), small handtools, by the index of farm and motor supplies (ASB), and blacksmithing and hardware, by the index of farm and motor supplies (ASB).

Agricultural Chemicals

Agricultural chemicals are comprised of pesticides and fertilizers, the latter including tons of commercially produced plant nutrients consumed and tons of liming materials. All price weights and deflators are from ASB.

For fertilizers and lime, the Tennessee Valley Authority (TVA) publishes annual estimates of tonnage consumption of nitrogen (N), phosphate (P_2O_5), and potash (K_2O), beginning in 1986 (*28*). NASS formerly published annual consumption estimates (*37*), but discontinued the series in 1986.

Tonnage of lime was formerly obtained from the National Lime Institute, but the discontinuation of this time series in 1984 forced ERS to begin extrapolating from past trends. Consumption data include nonfarm use, since there is no agreement as to how much is consumed as nonfarm use. In order to aggregate the plant nutrients, 1976-78 estimated prices are used for anhydrous ammonia (82 percent N), 46 percent P_2O_5, and muriate of potash (60 percent K_2O). These prices are converted to price per ton of nutrient, the unit of measurement of the consumption data. The data back to 1965 have been revised using the 1976-78 price weights. In earlier years, tonnages of the nutrients were summed without price weights.

The input index for herbicides, insecticides, and fungicides is based on current-dollar expenditures on these items as estimated by FSFAB from NASS data. The expenditures were estimated in earlier years using annual adjustments to the benchmarks provided by the SRS farm expenditures surveys of 1955 and 1971. Now, the annual FCRS provides the necessary information. For the annual adjustments, prices and shipments are obtained primarily from the annual publication, *Pesticide Review* (*57*).

ERS analysts in ITPB deflate the estimated expenditures by the ASB index of prices paid for agricultural chemicals, as published in *Agricultural Prices*, each year since 1965 (*30*). Before 1955, an index of lead arsenate, nicotine sulphate, and cube prices was the deflator. Between 1955 and 1965, a price index of copper sulphate, 2,4-D, and DDT was used. ITPB developed these latter two indexes, because no other suitable price deflators were available.

Chemicals such as feed additives, growth hormones, defoliants, and newer products are not included as separate items, although some are probably included within veterinary services and feed expenditures.

Feed, Seed, and Livestock Purchases

The feed, seed, and livestock purchases group includes that portion of feed, seed, and livestock purchases resulting from activities of the nonfarm sector; for example, feed and seed processing, transportation, and marketing service charges, such as milk hauling and livestock marketing. All estimates are deflated expenditures.

FSFAB estimates total feed expenditures in current dollars, using annual FCRS data. Benchmarks for quantities are obtained from the census of agriculture.

To estimate the nonfarm value added in purchased feed, analysts used data from the 1977 Census of Manufacturing to estimate a base period marketing margin. The marketing margin was expressed as the ratio between the value added by manufacturers, and the sum of value added and cost of materials, for Standard Industrial Classification (SIC) 2048, "Prepared feed—not otherwise classified." The margin was intended to capture the use of salt, minerals, and other additives, as well as processing and transportation services added in the nonfarm sector. Analysts multiply each year's expenditures on feed, as estimated by FSFAB, by the base period marketing margin. Current dollar expenditures are

deflated using the ASB index of prices paid by farmers for feed.

Expenditures for purchased seed, encompassing nine seed crops, are estimated by FSFAB, and deflated by the ASB index of prices paid for seeds. The nonfarm value added in seeds is estimated by means of a base period margin, as in the case of feed. ITPB estimated the base period margin from the ratio of the difference between ASB prices paid by farmers for seeds and received by farmers for seed crops in 1976-78, to the ASB prices paid by farmers for seed during the same period. Since nine distinct seed crops are included in the purchased seed component, the price indexes used to estimate the margin were weighted sums of individual seed crop price indexes. Individual crops were weighted by relative quantities used in 1976-78. Seed grown on the farm where used are not counted as an input, nor as an output of the farm sector.

Nonfarm value added in livestock and livestock product transfers are based on FSFAB estimates of expenditures on baby chicks and turkeys, minus prices received for hatching eggs adjusted for hatchability, milk hauling, and marketing charges for livestock. The number of baby chicks and turkeys, as reported by NASS, are multiplied by the base period weights. These weights are the difference between prices paid for the baby chicks and turkeys and the prices received for hatching eggs adjusted for hatchability. Milk hauling expenditures are deflated by the ITPB composite index of trucking costs. This composite index is the weighted sum of the index of farm wage rates (ASB) and the index of truck repairs, parts, and tires, which in turn is a composite of two BLS indexes, the index of prices paid for automobile repairs and maintenance, and the truck and bus tire price index.

FSFAB prepares annual estimates of national marketing, storage, and transportation expenditures for livestock from FCRS data. Benchmark data from the census of agriculture are used to extrapolate detailed marketing estimates. Livestock marketing charges include marketing, storage, and transportation expenditures for cattle, sheep, hogs, other livestock, eggs, and poultry, but exclude such expenditures for milk and dairy products. ITPB deflates current marketing expenditures by the ASB index of prices paid, interest, taxes, and wage rates (parity index).

Taxes and Interest

Real estate and personal property tax payments, estimated by ARED's Finance and Tax Branch (FTB), are viewed as a service flow in agricultural production. These payments are included in the input accounts to reflect intangible inputs such as education, farm-to-market roads, and research. Real estate taxes are adjusted to exclude dwellings. The current-dollar expenditures for real estate taxes are deflated by the ASB index of taxes paid on farm real estate, as published in *Agricultural Prices* (*30*). Personal property taxes are deflated by the BLS index of purchases of goods and services by State and local governments.

Sales and income taxes paid by farmers are not included because they are not regarded as production expenses for the farm enterprise, nor are data sufficient for their accurate measurement.

Farm interest expenditures include forgone interest on crop and livestock inventories, forgone interest on operating funds, and interest on non-real- estate debt. Constant-dollar values of crop and livestock inventories are determined by multiplying the quantity of each inventory by the base period prices received per unit. Livestock inventories are the average of each year's beginning and ending quantities valued at 1976-78 prices received (*34*, *47*, *59*, *60*). Crop inventories are estimated as half the January 1 stock estimates, since these inventories usually peak in January. NASS provides all inventory data. The service flow is estimated by multiplying the constant-dollar values by the 1976–78 mortgage rate of interest.

Operating capital is assumed to equal demand deposits of farmers, as estimated by FSFAB. A constant-dollar value is determined by deflating current-dollar demand deposits by the ASB index of prices paid, interest, taxes, and wage rates (parity index). The service flow is computed by applying the 1976–78 mortgage interest rate to the constant-dollar value of demand deposits.

Interest on non-real-estate or short-term debt is added as a separate service flow item, using estimates of total interest paid from FSFAB. However, ERS estimates the opportunity cost of non-real-estate debt by charging only the difference between the mortgage rate and short-term interest rate in the 1976–78 base period, since an interest charge on machinery inventories has already been made.

Miscellaneous Inputs

A variety of other farm expenditures constitute miscellaneous inputs. These expenditures are dairy supplies, such as detergents, pails, filters, and other items; fire, wind, hail, and Federal crop insurance; irrigation operation and maintenance; cotton ginning; expenditures for containers, such as baskets, bags, and crates; greenhouse and nursery supplies; binding materials; sorgo and sugarcane tolls; veterinary service; and business-related telephone charges. All are estimated by deflating current expenditure data.

FSFAB provides current-dollar expenditures for dairy supplies. Current dairy-supply expenditures were deflated by the CRB index using changes in prices paid for detergents until 1976, when the Statistical Reporting Service (predecessor of NASS) ceased to collect the required information. Since 1976, the detergent index has been updated with the ASB index of prices paid for production items. Capital items such as pipelines and bulk tanks are not included due to lack of data. Some of these items are captured indirectly in service building values.

Fire and wind insurance, hail insurance, and Federal crop insurance are also included as input service flows. FSFAB provides current expenditures on a net basis, that is, premiums paid by farmers minus indemnity payments

received by farmers. Expenditures for fire and wind insurance are deflated using the ASB index of prices paid for building and fencing materials. Expenditures for hail and Federal crop insurance are deflated by the ASB index of prices received for all crops. Beginning in 1985, insurance expenditures were no longer reported at the level of detail as before. ERS has extrapolated insurance expenditure estimates for the major categories of insurance in subsequent years.

Operating and maintenance expenditures on irrigation equipment are obtained from FSFAB. The only data specifically relating to irrigation are the fees paid to public and private sellers of water. Use of electricity and fuel for pumping are included elsewhere. ERS analysts deflate these expenditures by a price index of these services obtained from the Bureau of Reclamation. No service flow is included from the inventory or depreciation of irrigation equipment, or operator's time spent on irrigation activities.

The constant-dollar ginning charge is computed by multiplying cotton production in bales for the year and the 1976–78 cost of ginning per bale, as provided by ASB.

The expenditure data for other input items, including expenditures for containers, binding materials, veterinary services, and the farm share of telephone expenses, are obtained from FSFAB, using the annual FCRS. Each is deflated by ASB's prices-paid indexes for the closest category of items available:

- Containers—An index of prices of selected items including baskets, bags, and crates (ASB),
- Binding materials—An index constructed from the cost of baling twine (ASB),
- Veterinary service—An index of prices paid for farm supplies (ASB),
- Telephone—An index constructed from the base rate for local service (ASB).

Limitation of Series

The input index does not adequately measure changes in quality of inputs over time, an inherent problem with Laspeyres indexes. Also, because the input index is constructed entirely from secondary data, its accuracy depends on the accuracy of the secondary data. The national estimates for recent years are believed to be reasonably satisfactory, but regional estimates for many expenditure components are more doubtful, and depend on assumptions of the analyst when direct regional data are lacking. The changing structure of the agricultural industry is intensifying the problem of defining a farm. Integration of farm operations with farm input and marketing operations makes it difficult to price both inputs and outputs.

Publication of Series

Loomis and Barton (*23*) published decade-interval estimates for 1870–1910 and annual estimates for 1911–58. Since 1958, the input index has been published annually in *Production and Efficiency Statistics* (*42*), one of five reports in the ERS Economic Indicators of the Farm Sector series. Preliminary estimates are also published monthly in *Agricultural Outlook* (*29*). Preliminary indexes and other unpublished estimates are made available in response to specific requests. Many of these requests are for index numbers indicating the changes in use of some specific input or groups of inputs.

Required Hours of Farmwork, by Enterprise

The series on hours of required farmwork for livestock and crop production are used to establish the amount of, and to measure changes in, labor input in agriculture by various enterprises. ERS published estimates of total labor hours and indexes of labor use for each of 10 regions and 12 enterprise groups, including feed grains, hay and forage, food grains, vegetables, fruits and nuts, sugar crops, cotton, tobacco, oil crops, meat animals, milk cows, and poultry. The series was developed for each year by farm production region beginning with 1939, and for the United States beginning with 1910. ERS ceased to use the required-hours time series as a component in its total farm input index with the publication of the 1985 *Production and Efficiency Statistics* report (*42*), but temporarily continued a separate series for required hours to provide some estimate of labor use by enterprise group (table 4). ERS ceased to publish the required-labor time series in the 1987 *Production and Efficiency Statistics* report.

The time series for required labor hours is obtained by multiplying labor coefficients, which are estimated quantities of labor required for various production activities. These activities are ASB estimates of planted acreage (for preharvest labor), harvested acreage (for harvest labor), or weight units of production of animal numbers for livestock. A constant proportion of 13–15 percent, depending on the region in question, is added to the total labor hours for overhead labor. ERS obtained requirement coefficients for many of the commodity accounts on an individual commodity basis by consulting with State agricultural experts. This was done for the last time in 1964, though some labor coefficients for the major crops were revised in 1974 based on the USDA Costs of Production (COP) surveys.

The required-labor input data are not survey-based, but depend upon assumed engineering coefficients of labor needed to plant an acre of corn or a similar production activity. Labor hours reported in this series are not independent of the assumed level of efficiency and therefore may not reflect actual efficiency changes. Nonetheless, the series has provided the only published information concerning labor use by enterprise group.

Table 4—Labor indexes of hours required for livestock and crop production by U.S. enterprise groups

Year	Livestock and livestock products				Crops									
	All	Meat animals	Milk cows	Poultry	All	Feed grains	Hay and forage	Food grains	Vegetables	Fruits and nuts	Sugar crops	Cotton	Tobacco	Oil crops
							Index, 1977=100							
1950	367	222	560	525	263	399	257	158	188	132	220	1,237	304	89
1960	253	200	355	268	175	211	194	91	128	113	116	792	224	73
1970	155	153	166	168	110	114	125	74	105	96	120	232	126	92
1980	84	84	78	92	96	91	90	104	92	106	93	77	89	110
1981	80	78	72	88	97	92	87	112	93	103	96	75	92	104
1982	75	73	67	84	94	90	85	107	97	98	88	57	85	107
1983	71	70	61	79	84	70	82	89	90	96	88	39	71	95
1984	66	66	52	76	90	87	81	92	100	98	88	53	70	97
1985	63	62	48	74	88	90	79	85	99	101	89	49	59	88
1986	60	59	44	73	82	82	76	79	95	93	94	43	50	84

Note: Data series discontinued in 1987.

Construction of the Series

The series on hours of labor required in farming is built up by individual farm enterprises by applying hours per acre of crops and per head or unit of production of livestock to the official ASB estimates of acres and numbers of livestock. The hours per acre for each crop are divided into preharvest and harvest work. The hours of preharvest work are applied to the acres planted. They include time for such operations as hauling and spreading fertilizer, plowing and disking the land, planting or seeding, cultivating, irrigating, and spraying and dusting for pest control. The estimated hours for harvest work are applied to the acres harvested. They include time for the main harvesting operations and for hauling the crop to storage and to the local market or processing plant.

Hours needed for the care and production of livestock include direct labor for such operations as feeding, hauling feed and bedding, cleaning barns and pens, moving animals to or from pasture or range, caring for animals, and marketing animals and their products. Estimates of time for farm maintenance or general overhead work are calculated separately and added to the direct labor for crops and livestock to arrive at total hours for all farmwork. Maintenance labor includes time spent in constructing and maintaining fences, buildings, and irrigation and drainage structures, repairing machinery and farm power units, conservation work that is not part of a regular field operation, in work on permanent pastures and farm woodlots, conduct of the farm business, business trips, and a variety of other overhead tasks.

Estimates of annual hours per acre or per head of livestock are made by interpolating between or extrapolating from benchmarks. Benchmarks consist of estimates of labor used per acre and per head in each State. Benchmarks are then converted to a farm production region basis. The required benchmark coefficients were obtained on an individual commodity basis by consulting with State agricultural experiment station and extension experts. These State estimates for major benchmark years may be found in reports issued by the Bureau of Agricultural Economics (BAE, predecessor of ERS) and Agricultural Research Service (ARS), as well as by ERS (*7*, *12*, *13*, *16*, *17*, *18*, *19*, *24*).

Similar benchmarks for 1910, 1919, and 1929 were developed from data in the Works Progress Administration, National Research Project reports, which were summarized in a BAE report (*20*). These reports were based on extensive field surveys, while the previously mentioned group of studies was based on secondary data. State and Federal agencies have collected and published considerable data on labor requirements, and these data were used in estimating the State averages. Several sets of related data were used in developing the State averages. These included sources of farm power as indicated by numbers of tractors and workstock of farms, yield per acre and production per animal, methods of harvesting certain crops, and numbers of milking machines and other pieces of farm equipment. For States and commodities where insufficient data were available, interpolations were made using nearby States or similar commodities.

Procedures for the interpolation of the hours per acre for harvesting crops between benchmarks have been modified to take account of changes in yield and methods of harvest. The effect of changes in yield differs among crops and areas, but when harvesting is done by hand, the hours per acre vary more in relation to yield than when machine methods are used. Changes in yield make less difference with machine methods. Changes in method of harvest reduced the hours per acre.

Factors considered in estimating the labor rates per head or per unit of production between benchmark years for livestock include size of enterprise, such as cows per herd or

chickens per flock; production per animal, such as milk per cow and eggs per hen; and extent of different methods and practices followed, such as proportion of farms with milking parlors.

ERS last revised its benchmarks in 1964, and before that in agricultural census years. Since 1964, the 1959-64 trends have been extrapolated, with some modifications based on subjective judgments of changes in yields and developments in mechanization.

The labor coefficients for the major crops were reestimated from budgets based on the cost of production surveys of the Firm Enterprise Data System (*52*). These coefficients were first incorporated in the USDA labor input series in 1978. The value since 1974 has been extrapolated from 1969–74 trends, again based on subjective adjustments. In some instances, ERS staff decided not to use the revised coefficients, but continued to use coefficients based on the 1964 benchmarks. The trend factors used to annually extrapolate labor coefficients have not been modified since the mid-1970's.

Recognizing the inherent weaknesses of the labor requirements approach, the 1978 AAEA Task Force on Measuring Agricultural Productivity recommended that national labor hours be based on estimates of labor use derived from sample surveys (*52*). ERS responded to the AAEA's recommendation by developing a new survey-based labor series, which is based on data from the Farm Costs and Returns Survey (*26*, *27*).

There are three separate and independent labor surveys that measure aggregate labor hours in agriculture. The sample surveys of both NASS's Farm Labor Survey (FLS) and the Census Bureau's Current Population Survey (CPS) give independent estimates of labor use. The CPS is the basis for BLS estimates of labor use. The ERS/NASS Farm Costs and Returns Survey (FCRS) also provides an estimate of labor use but was not conducted until 1984.

Differences From Related Series

Two series which show numbers of persons employed on farms are frequently used to indicate the labor input in farming. NASS developed one of these series, and BLS developed the other, which is published monthly and consists of the agricultural segment of the employed civilian labor force (*65*).

The NASS farm employment series is the average number of farm operators, unpaid family workers, and hired workers as reported in the Farm Labor Survey. The series on total labor hours used can be derived from NASS employment data by adding two products. The first product is the average number of all family workers on farms, including self-employed and unpaid, multiplied by the average number of hours worked per week by this group, times 52. The second product is the average number of hired workers on farms multiplied by their average number of hours worked per week, times 52. The resulting series commences in 1965, the first year in which average number of hours worked per week became available.

While originally a monthly survey, the NASS Farm Labor Survey became quarterly in 1974. NASS reduced the frequency of labor surveys and associated farm labor reports in 1980. Two labor surveys were conducted in 1981, one in 1982, one in 1983, two in 1984, and four in 1985. When quarterly surveys resumed in 1985, the first (January) survey covered only seven States. Considering the seasonal variation associated with the agricultural labor force, a quarterly farm labor survey is the minimum necessary to produce an annual farm employment series.

The BLS series on farm employment shows the number of U.S. male and female workers, but without regional breakdowns. The BLS series is derived from the Census Bureau's monthly Current Population Survey (CPS). The Bureau of the Census and BLS have indicated that the sample is representative of the farm sector.

The BLS labor series has a major disadvantage. If an interviewee holds more than one job, all hours worked in all jobs are credited to the major job. If the interviewee's primary occupation is farmwork, all hours spent on nonfarm jobs are included as farmwork. Whether the BLS overstates or understates agricultural labor hours is uncertain.

A comparison of total labor hours during 1983–86 (table 5) shows substantial differences between the different labor use time series, though all series reveal a decline in labor use since 1947 (*26*, *27*).

Moreover, the gap between the earlier ERS labor requirements time series and alternative series has widened over time. The discrepancies can be attributed to the engineering formulas used in the earlier ERS labor requirements series, developed over 25 years ago, which understated overhead labor.

Between 1947 and 1964, the BLS series was about 24 percent larger than ERS's earlier series. After 1964, the spread between these two series widened considerably. By 1984, the BLS series indicated a labor use 75 percent greater than the earlier ERS series. The difference between the earlier ERS series and the one developed using NASS Farm Labor Survey data is also significant, reaching a high of 70 percent in 1979. The gap between the BLS series and the

Table 5—Total agricultural labor use

Year	Time series			
	Old ERS	New ERS	NASS	BLS
	Billion hours			
1983	3.2	NA	5.9	6.7
1984	3.3	6.4	5.8	6.2
1985	3.2	5.9	NA	5.7
1986	3.0	5.5	NA	NA

NA = Not available.

one developed using NASS data was considerably less, never reaching 20 percent.

The absolute number of hours reported in the new ERS series differs from estimates of the earlier labor requirements series, but the effect on the national aggregate indexes is small. For example, the total farm input and total factor productivity indexes for the Nation change less than 2 percent from previous estimates. This result is not surprising since all four labor series reflect the declining importance of labor relative to other inputs.

Because estimates of labor hours are used to develop financial indicators of the farm sector, the absolute value of these estimates becomes important. By changing only the labor component in the rate of return to equity in farm assets accounts, significant differences arose. The rates of return were different, especially in 1980 and 1983 where the NASS- and BLS-based series indicated negative rates of return as opposed to the positive ones in the earlier ERS series. The residual incomes to equity were negative in these two cases.

Given these results, ERS labor time series has adopted the BLS series and the FCRS as the two sources upon which the national labor input should be based. The NASS Farm Labor Survey series was not chosen because the reinstatement of monthly or even complete quarterly surveys is unlikely. The FCRS, instituted in 1984, provides labor hours for 1984 and later years, while the BLS time series provides labor hours for 1947–83.

Number of Farm Machines

This series provides estimates of inventories of six principal machines on farms and total amount of tractor horsepower in the United States. These machines are tractors (both wheeled and crawler types), trucks, grain combines, cornheads, pickup balers, and field forage harvesters. Benchmark data are available from the census of agriculture, except for tractor horsepower. ITPB prepares annual estimates for years between censuses.

Census data after 1954 reflected downward changes for automobiles, which were difficult to appraise because of limited information on quantities going to farms and discard rates for those already in inventory. Census counts of automobiles on farms from 1940 to 1955 showed little change, so that interim estimates, based on other sources, were excluded because of wide variations from the benchmarks.

The farm machine time series provides a broad general base for assessing farm mechanization and measuring inputs of power and machinery; establishing minimum requirements for power, machinery, and equipment in different phases of national defense planning; computing values for repairs, interest on investment, and depreciation of capital equipment; research and planning in government and industry on mechanical production inputs, particularly on a national basis; and a checkpoint on numbers of machines on farms for studies of machine use.

The inventory of machines includes those on farms (as defined in the census of agriculture), without regard to age, size, quality, or amount of use. Tractors and trucks were first enumerated in the census of agriculture in 1920. The annual time series, based on census counts, production, imports and shipments of machines, survey data, trends in census data, and estimated annual discard rates, began in 1939. Shipments of machines are reported by the Industry Division of the Bureau of the Census in the publication, *Current Industrial Reports* (*61*). Imports of tractors are reported by the Federal Trade Commission in FT-135 reports (formerly FT-110). Sales of wheel tractors, combines, pickup balers, field forage harvesters, and cornheads for combines are available from the Farm and Industrial Equipment Institute (FIEI).

While the ERS gross count of machines on the farm appears accurate, additional data regarding quality, use, age, and size of machines are needed to measure value, power inputs, and work capability. Recent information on sales of machines for farm use simplifies estimating the numbers of most machines going to farms. However, over time the census of agriculture has changed its farm definition and coverage of machines enumerated, making the calculation of discard rates more difficult. For instance, in the 1964 Census, only machines used in 1 of the 2 years prior to the census enumeration were counted. Before 1964, all machines on the farm were included in the count. The farm definition has not changed since 1974.

Horsepower of tractors on farms is calculated using data on horsepower shipped, FIEI annual sales data, and an assumed number of units discarded each year. Between 1964 and 1984, reports from the Bureau of the Census provided the quantity of horsepower shipped (*64*). In earlier years, average horsepower was estimated from the midpoints of horsepower ranges, weighted by the number of tractors shipped. Since 1985, estimates of tractor horsepower have been discontinued.

The series on number of farm machines is published annually (*42*). The release of July 1964 had annual data, including the number of horses and mules, beginning in 1910. In the release of July 1965, 5-year averages were shown for numbers of machines (1910–14, 1920–24, and 1930–34) with annual data beginning in 1939. Starting with the release in June 1967, a 5-year average was used for 1940–44 and annual data began with 1950. A new series on available tractor horsepower began in 1965, when numbers of horses and mules were dropped. Annual data on tractors and trucks starting in 1919, and on combines and cornpickers starting in 1940, are published in *Agricultural Statistics*. For historical data, see the issues of 1957, 1967, 1977, and 1987 (*33*).

At the time of the annual publication, revisions in machine inventories are made for the previous year as additional information becomes available. Further revisions are made for intervening years back to the previous census after a new census benchmark is established. Revisions may be extended back to a second preceding census benchmark if

significant changes have occurred in census definitions and concepts.

The series relates to, and is generally comparable with, other USDA series such as the mechanical power and machinery index (*42*); interest, depreciation, and repairs on capital items (*40*); and production assets (*41*).

Consumption of Commercial Fertilizers and Lime

The series on consumption of commercial fertilizers provides the total tonnage of fertilizer and primary plant nutrients (nitrogen, N; phosphorus, P_2O_5; and potash, K_2O) used in the 50 States and Puerto Rico. Tonnage for individual States by selected analyses and direct application materials have been estimated annually by TVA since 1986 (*28*). Before 1986, NASS published annual consumption estimates (*37*), but has discontinued the series. Fertilizer consumption statistics represent shipments of fertilizer to the ultimate consumer or to the last handler in the retail market chain. The figures are not the exact amount of fertilizer applied to the soil in any one year since there may be some carryover of stocks at the retail level. This series provides detailed information about State and regional use, kinds of nutrients applied, and common ratios and analyses of fertilizer used. Both farm and nonfarm use, combined, are included. Nonfarm use nationally may be as much as 3–4 percent of the total in recent years, but data are insufficient for accurately measuring and subtracting nonfarm uses. Since the purpose of the series is to measure domestic consumption, the total amount includes any imports of fertilizer into the country, but excludes exports. Tonnage estimates can be readily put into the form of indexes (table 6).

The total amount of micronutrients supplied by primary producers for ultimate use in both mixed and direct application fertilizers was first collected and published for the 1968 fertilizer year. Tons of elemental copper, iron, manganese, molybdenum, and zinc sold by producers were shown for the United States and by regions.

Table 6—Fertilizer: Primary plant nutrients and liming materials use, United States and Puerto Rico

Year	Primary plant nutrients				
	Nitrogen	Phosphate	Potash	Total	Liming materials
	Index, 1977=100				
1950	9	35	19	18	95
1960	26	46	37	63	72
1970	70	81	69	73	83
1980	107	97	107	104	110
1981	112	97	108	107	95
1982	103	86	97	97	74
1983	86	74	83	82	81
1984	104	87	99	99	85
1985	108	83	95	98	na
1986	98	74	87	89	na
1987[1]	97	71	83	87	na

NA = not available.
[1]Preliminary.

The Bureau of the Census provided the first information on the use of fertilizer in 1850. Until about 1910, data were available only from the census of agriculture. During 1910–33, annual consumption statistics were compiled by the National Fertilizer Association.

The Agricultural Research Service (ARS) first compiled fertilizer statistics in 1934 and issued periodic reports until 1941. Consumption reports were issued annually beginning in 1942. This function was transferred from ARS to the Statistical Reporting Service (SRS), the predecessor of NASS, in 1965. NASS published annual fertilizer consumption data (*37*), but discontinued the series after 1985. Beginning in 1986, TVA has published annual consumption estimates in *Commercial Fertilizers* (*28*).

The series on consumption of commercial fertilizers and lime is the only series which provides totals of final use of fertilizers and nutrients. Production statistics for basic chemical materials used by fertilizer manufacturers and other industries are collected by the Bureau of Mines and by the Bureau of the Census.

Fertilizer Supply (*44*), formerly published annually by the Agricultural Stabilization and Conservation Service (ASCS), showed the domestic supply of primary plant nutrients and the amount of nutrients supplied by the major fertilizer materials. The report continues to be prepared for State and local agencies but is no longer available to the public. This series, along with imports and exports, is often used to indicate apparent fertilizer consumption. However, there is a difference between the actual consumption data and apparent consumption because of changes in stocks, losses involved in fertilizer manufacture, and the inherent differences which occur in any independently collected series of data.

Most States have laws governing the sale of fertilizer. States collect fees based on the tonnage of fertilizer sold within the State and guarantee that farmers receive the amount of nitrogen, phosphorus, and potash purchased. Most States publish reports showing the total amount of fertilizer on which fees were paid. For these States, such reports provide the basis for the national report on fertilizer consumption. To check completeness of data, firms are asked to report to NASS the tonnage of fertilizer sold in particular States. These two sources of data are the basis for final estimates of fertilizer consumed. Any necessary revisions are published a year after the final fertilizer consumption report is issued. The statistics are used as a direct input into USDA's situation and outlook reports. They are also used by colleges and other research institutions to judge the effect of their educational and promotional programs. In addition, the Tennessee Valley Authority and individual companies use the data to direct their continuing research in fertilizer production, transportation, and sales.

The series on consumption of commercial fertilizers and lime does have limitations. Information on amounts of anhydrous ammonia, ammonium nitrate, and other fertilizer used is

inadequate, since these chemical materials, as well as direct application materials, are ingredients in mixed fertilizers. Those tonnages of primary nutrient materials shown in the report are only those applied directly to the soil.

Fertilizer consumption statistics are published annually (*28, 29, 33*) and quarterly (*32*). A long-term historical series was published in 1966 (*36*). The National Stone Association previously reported the use of limestone by States on an annual basis, but this series was discontinued after 1983. Current data on consumption of fertilizer and liming materials are published annually by ERS (*42*), and data from 1910 are available. Regional fertilizer consumption is not available before 1939.

Animal Units of Breeding Livestock Index

The index of animal units of breeding livestock is a weighted average of seven types of animal breeding units, computed annually for the United States. The index is based on numbers of milk cows and heifers that have been calved on January 1, beef cows and heifers that have been calved on January 1, ewes 1 year and older on January 1, hogs for breeding December 1 of the previous year, hens and pullets of laying age on December 1 of the previous year, breeding turkey hens on December 1 of the previous year, and goats clipped (table 7).

Table 7—Farm production: Indexes of animal units of breeding livestock and livestock production per breeding unit, United States

Year	Animal breeding units	Production per unit
	Index, 1977=100	
1950	106	66
1960	104	79
1970	100	99
1980	100	107
1981	101	108
1982	99	108
1983	97	112
1984	95	113
1985	92	120
1986	91	121
1987[1]	89	127

[1]Preliminary.

Current inventories of each of the seven types of breeding units are multiplied by their value weights. These value weights, in turn, are the products of output (such as milk) and price (such as milk price) for the base period. Value weights reflect the average contribution of each breeding unit to livestock production in the base period, currently 1976–78. For instance, the value weight for dairy cows and heifers is equal to the value of milk per breeding unit averaged over the 3-year period, 1976–78.

Every year, weighted aggregates are first separately determined for each of the seven categories. These aggregates are then added to represent the total price-quantity aggregate for all seven animal breeding units for that year. Finally, the price-quantity aggregate for animal breeding units in the current year are divided by the price-quantity aggregate for 1977 and multiplied by 100 to derive an index number. In this manner, a complete time series of indexes of animal breeding units can be constructed. Only a single national index is published for all animal breeding units combined.

The index is constructed for years 1919 to date (*42*). Five weight periods were used in combining the number of the various types of breeding units into a total. Value weights were recomputed in each base period. Average contribution of each breeding unit to livestock production in 1935–39 was the weight used for 1939 and prior years, 1947–49 weights were used for 1939–55, 1957–59 weights were used for 1955 to 1965, 1967–69 weights were used for 1965–75, and 1976–78 weights have been used from 1975 to the present. The five weight periods were spliced together at 1939, 1955, 1965, and 1975 by using overlapping calculations to derive one continuous index series for the current base-price period, 1976–78, with 1977 = 100.

The index differs in concept and purpose from other calculations of animal units in that it is used to derive an index of production per breeding units rather than an index of consumption per animal unit.

Most of the required information for constructing and updating the index of animal units of breeding livestock is available from NASS (*34, 47, 49, 59, 60*). However, breeding turkey hen inventories are no longer available for years after 1985. Inventories of breeding turkey hens are therefore estimated in 1986 and subsequent years by taking the average of the last 3 reporting years.

Production Per Unit

ERS publishes five productivity measures or indexes of production per unit of inputs each year. These include the multifactor productivity index, crop production per acre, an index of farm production per hour of labor, the number of persons supplied farm products by one U.S. farm worker, and an index of livestock production per breeding unit. The multifactor productivity index is the best overall indicator of productivity in the farm sector.

Multifactor Productivity Index

The multifactor productivity index is an index of farm output per unit of input, where all measurable inputs are considered rather than a single input such as labor. The multifactor productivity series is constructed from the index of agricultural inputs and the index of farm output, described earlier in this volume.

The purpose of the multifactor productivity index is to measure the overall productivity of U.S. agriculture. The multifactor productivity index is used by policymakers, legislators, farm groups, scholars, and the general public for appraising changes in the efficiency of converting resources into products.

The multifactor productivity series is computed by taking the ratio of the index of output to the index of inputs. These indexes are currently based on the reference year, 1977 (table 8). The productivity series is automatically revised following revision of the indexes of inputs and production from which it is derived. The indexes of output per unit of input are available each year for the 10 farm production regions beginning in 1939, and each year for the United States from 1910 to date and at decade intervals from 1870 to 1900.

Table 8—Indexes of U.S. farm output, input, and productivity

Year	Output	Input	Productivity
	Index, 1977=100		
1950	61	106	58
1960	76	99	76
1970	84	96	87
1975	95	97	99
1976	97	98	98
1977	100	100	100
1978	104	102	101
1979	111	105	105
1980	104	103	101
1981	118	102	116
1982	116	99	117
1983	96	97	99
1984	112	95	119
1985	118	92	128
1986	111	87	127
1987[1]	110	86	127

[1]Preliminary.

The productivity indexes are published each year by ERS in *Production and Efficiency Statistics* (*42*), and by the Council of Economic Advisors in the *Economic Report of the President* (*8*). The preliminary index of farm output per unit of input is usually made available in the September issue of *Agricultural Outlook* (*29*).

Crop Production Per Acre

The index of crop production per acre measures the average change in production per acre of cropland used for crops. It is the ratio of the index of total crop production to the index of cropland used for crops. Cropland used for crops includes land from which one or more crops are harvested, land with crop failure, and land cultivated for summer fallow (table 9).

Over time, indexes of crop production per acre reflect changes in average yields and in the composition of crop acreage. Indexes are calculated for the United States, beginning in 1910, and for each of the 10 farm production regions beginning in 1939.

Indexes of crop production per acre are published annually by ERS in *Production and Efficiency Statistics* (*42*), and by USDA in *Agricultural Statistics* (*33*). The U.S. Bureau of the Census also publishes the index in the annual *Statistical Abstract of the United States* (*62*), as does the Council of Economic Advisors in the *Economic Report of the President* (*8*).

Index of Farm Production Per Hour of Labor

The index of farm labor productivity is the ratio of farm production to labor input. This series is one of a number of partial measures of efficiency which relate farm output to an important input, such as farm labor. The index numbers are developed by relating national and regional indexes of farm output to the appropriate index of labor input expressed in labor hours. Estimates of labor used are survey-based (table 10).

Indexes of farm labor productivity reflect the net impact of factors on either farm production or the labor input. To attribute all the changes in efficiency to farm labor, however, is incorrect. Labor is one of the more important inputs in agricultural production. Changes in the ratio of production to labor provide a useful measure of changes in efficiency of farm production. Nonetheless, the farm labor productivity index should be interpreted with care when considering changes in mechanization, yields of crops and livestock, and the other technological forces that operate on labor input and farm production.

Indexes of farm production per labor hour are calculated and published annually from 1947 to date, in ERS *Production and Efficiency Statistics* (*42*) and USDA's *Agricultural Statistics* (*33*).

Measurement and analysis of current changes, regional differences, and trends in farm production per hour of labor

Table 9—Indexes of crop production per acre, by region

Year	Northeast	Lake States	Corn Belt	Northern Plains	Appalachian	Southeast	Delta States	Southern Plains	Mountain	Pacific	United States
					Index, 1977-100						
1950	81	51	51	49	82	62	82	49	64	58	59
1960	93	67	67	69	100	91	109	78	81	70	77
1970	108	85	82	75	111	111	106	87	92	84	88
1980	104	100	102	92	95	102	81	79	111	113	100
1981	112	106	114	116	118	130	110	106	117	112	115
1982	114	114	117	120	120	133	118	91	116	115	116
1983	104	101	88	102	88	122	98	97	110	114	100
1984	116	110	105	118	116	129	118	100	107	121	112
1985	120	114	124	129	111	135	114	105	104	124	120
1986	113	114	124	131	96	122	106	93	112	122	116
1987[1]	112	119	122	127	100	139	122	116	124	139	122

[1]Preliminary.

Table 10—Indexes of farm production per hour, by region

Year	Northeast	Lake States	Corn Belt	Northern Plains	Appalachian	Southeast	Delta States	Southern Plains	Mountain	Pacific	United States
					Index, 1977-100						
1950	27	20	19	27	23	22	13	19	27	36	22
1960	47	37	36	51	41	46	29	41	48	57	42
1970	80	65	66	78	81	83	72	69	84	86	74
1980	116	115	112	102	106	106	95	95	117	115	109
1981	133	128	124	124	124	130	118	119	128	121	123
1982	134	133	123	129	127	139	127	112	126	116	125
1983	118	112	84	105	93	112	94	95	110	101	99
1984	83	80	95	125	159	258	154	92	113	197	121
1985	87	87	127	160	166	274	176	111	109	185	139
1986	88	96	114	166	166	221	178	118	140	166	139
1987[1]	101	92	112	167	162	220	179	136	124	196	142

[1]Preliminary.

provide essential information in making agricultural policy and program decisions. Analyses of factors responsible for changes in farm labor productivity are important in appraising and analyzing farm wage rates, labor and other farm costs, and efficiency in farm production. The series showing farm output per labor hour provides data useful for agricultural-industrial comparisons of labor productivity.

Caution should be exercised when comparing the ERS series with those of the Bureau of Labor Statistics (BLS) because of differences between gross and net farm production. BLS computes indexes of production per hour for the total private economy, for nonagriculture, and for agriculture (*65*). Like the ERS series, the BLS series calculates indexes of farm production in which production data are weighted by constant prices. The ERS farm output index is a gross index while the production index of BLS follows the gross national product approach, which is a net index excluding intermediate products.

Persons Supplied Farm Products by One U.S. Farmworker

This series measures the average number of persons, both U.S. citizens and foreign residents, who are supplied food, fiber, and tobacco by one U.S. farmworker. The series provides a simple, easily understood measure of productivity of persons employed in farming, including farm operators, unpaid family workers, and hired workers. It is one of several partial productivity measures published by USDA (table 11).

The conceptual limitations of the series should be clearly understood. Observed increases in agricultural productivity cannot be attributed to the farmworker alone. Over the years, many functions previously performed onfarm have been transferred to nonfarm business firms. An example of this is the shift from farm-produced power to tractor manufacturing firms, as farmers adopted mechanized farming in place of horses and mules. Feed preparation and custom

Table 11—Persons supplied farm products by one U.S. farmworker

Year	Persons supplied per farmworker			Total employment	Total U.S. population July 1
	Total	At home	Abroad		
	Number			*Millions*	
1950	15.5	13.8	1.7	9.9	151.7
1960	25.8	22.3	3.5	7.1	180.8
1970	47.9	40.6	7.3	4.5	205.1
1980	75.8	52.3	23.5	3.7	227.8
1981	75.4	54.8	20.6	3.6	230.0
1982	78.7	60.0	18.8	3.4	232.3
1983	86.7	63.1	23.6	3.2	234.5
1984	87.8	64.6	23.1	3.1	237.0
1985	88.0	70.4	17.6	2.9	239.3
1986	92.7	74.9	17.9	2.7	241.5
1987[1]	96.0	76.2	19.8	2.7	243.8

[1]Preliminary.

services have been transferred more recently to nonfarm enterprises. In our own time, biotechnology and computerized farm management are revolutionizing American agriculture. These changes mean that many nonfarm workers now perform functions formerly done by farmworkers. The persons-supplied time series does not quantify the contribution of nonfarmworkers to farm output.

As functions are transferred from farmworkers to nonfarm workers, employment in farm production declines. The number of nonfarm workers engaged in production of goods and services used by farmers increases relative to farmworkers. The series thus overstates the contribution of farmworkers and ignores the growing importance of nonfarm workers in agricultural production.

The series on persons supplied farm products by one U.S. farmworker covers the 48 conterminous States through 1959, and 50 States thereafter. Estimates are available for decade years from 1820 to 1940 and annually thereafter. Four sets of data are used in computing the series:

(1) The farm employment series is the annual average number of farm operators, unpaid family workers, and hired workers based on National Agricultural Statistics Service (NASS) *Farm Labor Reports* (*43*) rounded to the nearest 100,000.

(2) The total U.S. population is that reported by the Bureau of the Census for July 1, rounded to the nearest 100,000. Data follow current Census definitions, which since 1940 have included U.S. military forces overseas (*63*). Census population estimates are available from the *Economic Report of the President* (*8*), issued in January of each year.

(3) The values of agricultural exports and imports are those published by ERS in *Foreign Agricultural Trade of the United States*, which appears six times a year, with two annual supplements (*45*). The fiscal-year supplement appearing in May is the source used for estimating persons supplied. The FATUS reports in turn are based on data supplied by the Bureau of the Census and customs records.

(4) The value of domestic production is published by ERS in *Economic Indicators of the Farm Sector: National Financial Summary*, an annual publication prepared primarily from data supplied by NASS (*41*).

The computation of the number of persons whose agricultural needs are met by one U.S. farmworker proceeds in three basic steps, which in turn are made up of several subsidiary steps. First, the analyst estimates the number of persons supplied U.S. farm products at home and living abroad. This requires a number of distinct calculations.

The total-dollar value of all farm products available domestically is equal to the dollar value of U.S. farm production minus the value of agricultural exports plus the value of agricultural imports. This figure represents the value of all farm products available to the U.S. consumer, whether produced domestically or abroad. If inventory changes are ignored, the ratio of the dollar value of all farm products available domestically to the U.S. population is, of course, the per capita consumption of farm products by U.S. residents. Clearly, the number of persons supplied by the total-dollar value of all farm products available domestically is none other than the U.S. population itself.

Some portion of U.S. farm product consumption is supplied by foreign farmworkers, and some portion is supplied by U.S. farmworkers. The value of U.S. farm production for domestic use equals the value of total U.S. farm production minus exports. This amount represents the value of U.S. farm production which is in fact supplied to U.S. residents. The difference between the total value of all farm products available domestically and the value of U.S. production available domestically is the value of imports.
If we take the ratio of the value of U.S. farm production available domestically to the value of all farm products available domestically, this represents the proportion of total U.S. farm product supply originating in this country. The product of this ratio and the U.S. population gives the number of persons in the United States who could be supplied with agricultural products from U.S. farm production alone.

The ratio of the value of U.S. imports of farm products to the total value of all farm products available domestically is the proportion of total U.S. farm product supply from abroad. The product of this ratio and the U.S. population gives the number of persons at home supplied by foreign farmworkers.

Estimating the number of persons living abroad who are supplied by U.S. farm products is done in the same manner. The ratio of the value of exports to the total value of all farm products available domestically is multiplied by the

U.S. population. This gives the number of persons abroad who could be supplied with agricultural products from U.S. farm production. One very important assumption underlies this calculation, namely, that foreigners consume on a per capita basis the same value of agricultural products as U.S. residents.

The second step is to determine total U.S. farm employment. Because they are integral to the estimation process, the series on total farm employment and total U.S. population are published along with the series on persons supplied by the production of one farmworker. Data for 1910-80 are taken from releases on farm employment issued by NASS, rounded to the nearest 100,000 (*43*). Since 1980, NASS has reduced the number of labor surveys and associated farm labor reports. Only two labor surveys were conducted in 1981, one in 1982, one in 1983, two in 1984, and four in 1985. Since the reinstitution of quarterly surveys in 1985, the first (January) survey covered only seven States. Considering the seasonal variation associated with the agricultural labor force, a quarterly farm labor survey is the minimum necessary to produce an annual farm employment series. For this reason, the farm employment series from 1981 to the present is a trend estimate.

The trend estimates depend upon the availability of national farm labor data for three out of four quarters in 1985, 1986, and later years. These quarterly surveys are carried out by NASS in April, July, and October (*43*). The seven-State survey is conducted in January, when farm labor can be expected to be seasonally low. The last year for which complete information was available for all four quarters was 1980. The total farm employment in April, July, and October of 1980 was compared with reported U.S. farm employment during these 3 months in 1985, 1986, and 1987. Percentages were calculated by taking the ratio of total U.S. farm employment of the current year to that reported in 1980 for these three quarters. In this manner, percentages were determined for 1985, 1986, and 1987. These percentages were applied to the total U.S. average farm employment for 1980 to estimate average U.S. farm employment for 1985, 1986, and 1987. Alternative estimation procedures provided similar, but lower figures.

Between 1980 and 1985, interpolation was required. The estimated difference in total U.S. average farm employment between 1980 and 1985 was 764,100, for an average annual rate of decline of 152,820 based on straight-line interpolation. Average annual U.S. farm employment was estimated for 1981, 1982, 1983, and 1984, by assuming a 152,820-person annual rate of decline. Thus a complete farm labor employment series existed for constructing the series on persons supplied farm products by one U.S. farmworker.

The new availability of quarterly farm employment data from NASS necessitated a change in the trend estimation procedure in the 1986 *Production and Efficiency Statistics* report (*42*). As a result, previously published numbers for 1982 through 1985 have been revised.

The January 1989 FLS was expanded to include all States, except Alaska. ITPB analysts therefore have four complete quarterly labor surveys for estimation of farm employment, beginning in 1989.

In the third and final step, the sum of the estimates of domestic and foreign residents supplied U.S. farm products is divided by total U.S. farm employment to obtain numbers of persons supplied farm products by one U.S. farmworker.

As a rough measure of productivity in the farm sector, the series serves a definite purpose. It is not intended to be a precise index of slight year-to-year variations in worker efficiency. Short-term variations may stem from changes in the value of agricultural products available for consumption in the United States, changes in the value of exports of agricultural products, and changes in farm employment and population.

Current data are published annually by ERS in *Production and Efficiency Statistics* (*42*), and by USDA in *Agricultural Statistics* (*33*). Computation is undertaken each year, with revisions for the previous 2 years.

Index of Livestock Production Per Breeding Unit

The computation of animal units of breeding livestock described earlier in this volume is also used to derive an index of livestock production per breeding unit. This index is based fundamentally on a weighted average measure of production per unit of the various livestock breeding units such as milk cows, hens, pullets, and breeding sows (table 7).

The index is constructed in three steps. First, the price-quantity aggregate of production of each of the seven animal breeding units is computed and summed for each year. The summed price-quantity aggregate is the total livestock production of all seven breeding units, where current quantities and the base period price weights are used in calculation. Production of milk per cow and eggs per layer are typical measures of output:

(1) Milk cows and heifers: dairy products
(2) Beef cows and heifers: meat
(3) Ewes: wool, sheep, and lambs
(4) Hogs and pigs: meat
(5) Hens and pullets: eggs and meat
(6) Breeding turkey hens: meat
(7) Goats clipped: mohair

In the second step, the ratio of total livestock production to total animal breeding units is calculated. The numerator is the sum of the price-quantity aggregates for all seven species of breeding units, where quantity represents current output and price denotes the base period price weight (1976-78). The denominator is the previously determined (weighted) number of animal units of breeding livestock. The sum of the price-quantity aggregates for the seven species is divided by the animal units of breeding livestock to compute a ratio of livestock production to breeding units. This ratio is calculated for both the current period and the reference year

(1977). For instance, two computations are carried out in 1986:

In 1977, [44,037,345] ÷ [44,025,784] = 1.0002625

In 1986, [48,567,488] ÷ [39,963,356] = 1.2153005

The weighted price-quantity aggregates are in thousands of base period dollars.

The index of livestock production per breeding unit is derived in the third and final step. The current year's ratio (1986 for instance), calculated in the second step, is divided by the ratio for 1977 and multiplied by 100. This calculation produces the index of livestock production per breeding unit for each year. The year, 1977, is indexed to 100:

In 1986, [1.2153005] ÷ [1.0002625] × 100

= 121.498 or 121

An index for each year is determined in the same fashion.

Each year, the current year's index of livestock production is estimated, and the previous year's index is revised (*42*). There is only one national index computed and published, combining all seven species on a weighted basis. No regional indexes are calculated or published. Livestock production levels are obtained from NASS published and unpublished information.

The livestock production index is useful in two ways. It helps analyze changes in productivity of farm labor and of other inputs in agriculture, and it is one of the family of productivity ratios that helps to gauge the effects of changing technology on agricultural production.

Planned Changes in Productivity Series: A New Tornqvist Multifactor Productivity Index

The ERS Laspeyres productivity indexes have been praised for their comprehensiveness and criticized for their shortcomings. The total farm output per unit of input was the first multifactor productivity measure published by a Federal agency, and until the Bureau of Labor Statistics (BLS) recently constructed its own multifactor productivity index, the ERS measure remained the only such index regularly published by any government agency. Yet, the ERS index has been the subject of frequent criticism from the agricultural economics profession. Griliches (*15*) faulted the input index for not accounting for quality changes in inputs. He found flaws in the measurement of the capital stock and its resulting service flows. The National Academy of Sciences (*25*) and the American Agricultural Economics Association (*52*) expressed concern about the indexing procedures used in computing the ERS multifactor productivity indexes. These concerns have also been expressed by Christenson (*5*).

The U.S. Department of Agriculture is now taking steps to improve its existing productivity indexes by introducing a new Divisia-based national multifactor productivity index, based on the original work of Eldon Ball (*1*). USDA will begin publishing the new series in the 1988 *Production and Efficiency Statistics* report (*42*), which should appear in 1990. The older Laspeyres indexes will temporarily continue.

Important theoretical developments in index number theory provided the conceptual basis for Ball's innovative research. The oldest index formulas used by economists historically are Laspeyres and Paasche indexes. Laspeyres formulas use base-period weights, while Paasche formulas use comparison-period weights in aggregating heterogeneous inputs and outputs.

A Laspeyres index is exact to a linear production function, with perfect substitutability between all inputs in the process. The use of fixed-price weights over an extended period will not reflect the appearance of new inputs and outputs, improved quality of inputs, or shifts in relative prices between inputs. Fixed relative prices are not a realistic assumption, especially in the agricultural sector. Observed productivity indexes will confound true productivity changes with factor substitution. If the price of factor x increases relative to factor y, farms will use more of input y and less of input x. Two changes have occurred. The relative price of x increases but its relative quantity used decreases. These two changes have opposite effects on the cost shares or weights. Moreover, Laspeyres indexes assume a linear production function which is additive in its arguments, hardly an adequate model of the production process. These deficiencies have led economists to search for alternative indexing formulas, which impose less stringent assumptions.

One alternative increasingly favored by production specialists is the Divisia index, first developed in the 1920's. The Divisia index is a weighted sum of growth rates, where the weights are the input components' shares in the total value of inputs used. The Divisia index is exact for a homogeneous translog production function, which implies no arbitrary restriction on substitution between factors. Since the translog function is continuous, a discrete approximation is necessary for actual empirical use.

The Tornqvist index is a discrete approximation of the Divisia index, with variable factor share weights. The weights of the Tornqvist index are based on arithmetic averages of cost shares of the present and previous period. However, the geometric average is typically used for computational convenience. Numeric differences between these methods are usually slight and considered insignificant. Computation is usually annual.

Diewert (*9*) categorized the Divisia index as superlative, since it is exact to a flexible functional form. A flexible functional form such as the translog can give a second-order approximation to any functional form. Thus, use of a superlative index does not require knowledge of the true function.

Tornqvist indexes are an improvement over Laspeyres indexes for three reasons. First, a Tornqvist index recognizes that input factor prices and quantities observed in a given year are most relevant for computing weights in that year. Annual reweighting more adequately reflects changed production relationships. Second, the Tornqvist approximation is superlative by being exact to a flexible production function or translog function, with variable substitution possibilities. Third, the Tornqvist index remains appropriate even when tastes or technology are changing over time. The Tornqvist index has the property that, as a chained index, it measures changes relative to the previous period, rather than relative to a fixed base period. Therefore, the Tornqvist index can better handle shifting tastes and technology, since chained indexes adjust rapidly to the latest form of a shifting aggregator function.

Given these desirable properties, the AAEA committee (*52*) strongly recommended the use of Tornqvist indexes for the official ERS productivity measures. Along with the shift toward Tornqvist indexes, ERS will make substantial improvements in its estimate of the individual input components. ERS is moving in the direction of a quality-adjusted labor input measure, by adopting the Gollop and Jorgenson (*14*) labor series. Based on a detailed examination of wage rates and hours worked by sociodemographic characteristics of the work force, Gollop and Jorgenson broke down labor into 2 sexes, 8 age groups, 5 educational groups, 2 employment classes, and 10 occupational groups. Fully disaggregated cells are not always available, but estimation techniques are available for imputing the values of cells not directly observable. However, the imputed compensation for operator and family labor is the same as for hired labor. Future research will explore the possibility of estimating imputed returns to labor

by category of labor, taking account of differences in education and work experience.

The new Tornqvist indexes also will provide an independent estimate of the return to capital. The older series uses short-term interest rates as proxies for the true return to capital. The new Tornqvist series models the agricultural sector as a producer of capital goods (breeding stocks) for delivery to the sector's own capital accounts. The older ERS series does not consider breeding stocks as capital goods.

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Appendix I—Farm Production Index Catalog (1975-present)[1]

This appendix lists all commodities, grouped according to 11 crop and 4 livestock categories, included in the multiple output index since the last splice year, 1975. Other commodities, not listed here, are included in the multiple output index for years prior to 1975. NASS discontinued annual surveying for numerous commodities in 1982, mainly in the fruits and nuts and vegetables commodity groups. These groups have been noted in the list. ERS estimated current output for these commodities by taking the 3-year average of output for the last 3 reporting years.

Number	*Crops*
8100	**Feed Crops** (CO-1)
8110	Corn
8120	Oats
8130	Barley
8140	Sorghum for grain
8145	**Hay and Forage** (C0-2)
8150	Hay, all
8180	Corn silage
8190	Sorghum silage
8195	Feed fed (subtracted from total farm output)
8200	**Food Grains** (CO-3)
8210	Wheat
8220	Rice
8230	Rye
8300	**Fruits and Nuts** (C0-4)
8305	Bananas
8309	Papayas
8311	Apples
8313	Apricots
8314	Avocados
8315	Cherries, sweet
8317	Cherries, tart
8319	Cranberries
8321	Dates
8323	Figs
8325	Grapes
8327	Nectarines
8329	Olives
8331	Peaches
8333	Pears
8337	Pineapples
8339	Fresh plums and prunes
8341	Pomegranates
8343	Strawberries (Fresh)
8344	Strawberries (Processed)
8345[2]	Red raspberries
8347[2]	Black raspberries
8348[2]	Black blackberries
8349[2]	Blueberries
8351[2]	Currants
8353	Boysenberries and young berries
8355[2]	Loganberries
8371	Grapefruit
8373	Lemons
8375	Limes
8377	Oranges
8379	Tangelos
8381	Tangerines
8387	Macadamia nuts
8389	Pistachios
8391	Almonds
8393	Filberts
8395	Pecans, all
8397	English walnuts
8400	**Vegetables** (CO-5)
8410	**Fresh Vegetables**
8411[2,3]	Asparagus
8413	Broccoli
8415[2]	Cabbage
8417[2]	Cantaloups
8419	Carrots
8421	Celery
8423[2]	Eggplants
8425[2]	Green pepper
8427[2]	Watermelons
8429	Tomatoes
8431[2]	Brussels sprouts
8433	Cauliflower
8435	Lettuce
8437[2]	Cucumbers
8439	Sweet corn
8441	Snap beans
8445	Onions
8447[2]	Garlic
8449[2]	Spinach
8451	Honeydew melon
8453[2]	Escarole
8455[2]	Artichokes
8470	**Processed Vegetables**
8471[2]	Lima beans
8473	Snap beans
8475[2]	Beets
8477	Sweet corn
8479[2,3]	Cucumbers
8481	Green peas
8482	Carrots
8483[2]	Spinach
8484	Broccoli
8485	Tomatoes
8486	Cauliflower
8487[2,3]	Asparagus
8488[2]	Cabbage
8490	**Other Vegetables** (except truck)
8491	Edible beans
8493[2,3]	Dry peas
8495	Irish potatoes

Number	*Crops*
8497	Sweet potatoes
8498	Mushrooms
8499	Taro
8500	**Oil Crops** (CO-6)
8510	Soybeans
8520	Peanuts
8540	Flaxseed
8560	Cottonseed
8570	Sunflower
8600	**Fiber Crops**
8610	Cotton (CO-7)
8620	Tobacco (CO-8)
8700	**Sugar Crops** (CO-9)
8710	Beets
8720	Cane for sugar and seed
8750[2]	Maple syrup
8800	**Seed Crops** (CO-10)
8812[2]	Alfalfa
8816[2]	Bentgrass
8820[2]	Lespedeza
8824[2]	Red clover
8832[2]	Timothy
8836[2]	Crimson clover
8840[2]	Ladina clover
8844[2]	Chewing fescue
8848[2]	Red fescue
8852[2]	Tall fescue
8856[2]	Hairy vetch
8860[2]	Kentucky bluegrass
8864[2]	Orchard grass
8868[2]	All rye grass
8876[2,3]	Wrinkled seed peas
8900	**Miscellaneous Crops** (CO-11)
8920	Hops
8930[2]	Popcorn
8935	Peppermint
8940	Spearmint
8950	Coffee

Product	*Livestock*
9100	**Meat Animals** (LO-1)
9110	Beef cattle
9130	Veal calves
9150	Sheep
9170	Lambs
9190	Hogs
9300	**Dairy Products** (LO-2)
9330	Milk wholesale
9350	Milk, retail
9370	Milk used on farm
9500	**Poultry** (LO-3)
9510	Eggs
9530	Broilers
9550	Chickens
9570	Turkeys
9590	Hatching eggs
9700	**Miscellaneous Livestock Products** (LO-4)
9710[2,3]	Honey
9730[2]	Beeswax
9750	Wool
9770	Mohair

[1]As of May 5, 1989.

[2]Discontinued by NASS.

[3]Reactivated by NASS, following discontinuance.

Appendix II—Input Index Catalog[1]

This appendix lists all inputs, grouped by category, included in the ERS index of multiple inputs. For each input or input group, years for which data are included in the multiple input index are noted. In addition, since price deflators play such an important role in the derivation of constant dollar input quantitites, the catalog lists the code number for the specific price deflator used for each input, where the deflation procedure is applied. No price deflators are necessary when quantities can be directly observed. The price deflator codes are explained in Appendix III.

Input Number	*Category*	*Years*	*Price deflator code*[2]
1000	**Farm labor**	1870-1900	--
1101	Hired labor (including perquisites)	1910-87	--
1400	Operator labor plus unpaid family labor	1910-39	--
1401	Operator labor	1939-87	--
1402	Unpaid family labor	1939-87	--
2000	**Farm Real Estate**	1870-1900	--
2100	Interest on land and service buildings at the mortgage rate of interest	1910-39	--
2101	Interest on equity in land and service buildings (real estate service charge)	1939-87	--
2102	Interest on real estate mortgages	1939-87	88
2105	Land services leased to government on voluntary basis	1956-65	--
2301	Capital consumption: Service buildings and land and water improvements (depreciation on service buildings and other structures)	1910-87	15
2401	Accidental damage to service buildings and machinery	1910-87	15
2501	Repairs on service buildings, other structures and land improvements	1910-87	14
2800	Grazing fees, total	1910-87	12
2801	Grazing fees, State forests	1939-65	--
2802	Grazing fees, National forests	1939-65	--
2803	Grazing fees, public domain (Taylor Grazing Act lands)	1939-65	--
2805	Grazing fees, military lands	1939-65	--
2806	Grazing fees, Indian reservations	1939-65	--
3000	**Mechanical Power and Machinery**	1870-1900	--
3002	Interest on inventory of machinery and motor vehicles: sum of 3102,3302,3402,3602	1910-87	--
3101	Auto depreciation, farm share	1910-87	20
3102	Interest on auto inventory, farm share	1910-87	99
3108	Auto repairs, parts and tires, farm share	1910-75	44
3110	Auto repairs, parts, tires, licenses and insurance	1975-87	45
3200	Auto licenses and insurance, farm share	1910-39	06
3201	Automobile licenses, farm share	1939-75	06
3202	Automobile insurance, farm share	1939-75	06
3301	Tractor depreciation	1910-87	30
3302	Interest on tractor inventory	1910-87	99
3303	Tractor and other farm machinery, repairs, parts, and tires	1975-87	51
3305	Tractor repairs, parts, and tires	1910-75	52
3401	Truck depreciation	1910-87	28
3402	Interest on truck inventory	1910-87	99
3405	Truck repairs, parts and tires	1910-75	48
3410	Truck repairs, parts, tires, licenses and insurance	1975-87	49
3500	Truck licenses plus truck insurance	1910-39	6
3501	Truck licenses	1939-75	6
3502	Truck insurance	1939-75	6
3601	Depreciation on other farm machinery	1910-87	32
3602	Interest on inventory of other farm machines	1910-87	88
3605	Other farm machines: repairs, parts, and tires	1910-75	54
3701	Fuel and oil (including gasoline)	1910-87	34
3801	Electricity, farm share	1910-87	36
3802	Blacksmithing and hardware	1910-87	16
3804	Harness and saddling	1910-87	38
3808	Small handtools	1910-87	16

Input Number	*Category*	*Years*	*Price deflator code*[2]
3809	Steam engines	1910-29	--
3901	Custom work	1939-87	40
4000	**Agricultural chemicals**	1870-1900	--
4100	Nitrogen phosphorus, and potassium plus mixing costs	1910-39	--
4105	Fertilizer mixing costs	1939-65	--
4121	Nitrogen fertilizer	1939-87	56
4131	Phosphate fertilizer	1939-87	56
4141	Rock phosphate fertilizer	1939-65	--
4151	Potassium fertilizer	1939-86	56
4222	Limestone	1910-87	--
7407	Pesticides	1910-87	70
5000	**Feed, seed, and livestock purchases (non-farm value-added)**	1870-1900	--
5100	Total seed input (5101-5115)	1910-87	58
5101	Seed: Corn, hybrid	1939-65	--
5102	Seed: Corn, open pollinated	1939-65	--
5104	Seed: Oats, spring	1939-65	--
5106	Seed: Wheat, spring	1939-65	--
5108	Seed: Soybeans	1939-65	--
5110	Seed: Barley, spring	1939-65--	
5112	Seed: Cottonseed	1939-65	--
5115	Seed: Minor grains plus all seeds other than grains (includes greenhouse and nursery supplies)	1939-65	--
5200	Total feed input (5210-5240)	1910-87	60
5210	Feed: Grain handling by local elevators on grains fed as such	1939-65	--
5220	Feed: Byproduct processing cost	1939-65	--
5230	Feed: Marketing cost on byproduct fed as such	1939-65	--
5240	Feed: Formula feed formulating and marketing cost	1939-65	--
5300	Total livestock (5301-5702)	1965-87	84
5301	Hired trucking, freight and express (livestock transportation only, prior to 1939)	1910-65	--
5302	Milk hauling	1939-87	55
5401	Livestock marketing	1910-87	10
5600	Baby chickens purchased	1910-39	--
5601	Baby chickens purchased, broiler	1939-87	--
5602	Baby chickens purchased, layer	1939-87	--
5700	Baby turkeys purchased	1910-55	--
5701	Baby turkeys purchased, heavy	1955-87	--
5702	Baby turkeys purchased, light	1955-83	--
6000	**Taxes and interest (for the period 1870-1900, real estate plus personal property taxes)**	1870-1900	--
6101	Taxes: Real estate (use P/I 63 prior to 1965)	1910-87	62
6105	Taxes: Personal property	1910-87	63
6201	Interest on livestock inventory (6203-6207)	1910-39	--
6203	Interest on inventory of all cattle and calves	1939-87	89
6204	Interest on inventory of hogs and pigs	1939-87	89
6205	Interest on inventory of sheep and lambs	1939-87	89
6206	Interest on inventory of all chickens	1939-87	89
6207	Interest on inventory of all turkeys	1939-87	89
6208	Interest on corn inventory	1939-87	89
6209	Interest on oats inventory	1939-87	89
6210	Interest on crop inventory (sum of 6208, 6209, 6211, 6212, 6213, 6214)	1910-39	--
6211	Interest on barley inventory	1939-87	89
6212	Interest on grain sorghum inventory	1939-87	89
6213	Interest on hay inventory	1939-87	89
6214	Interest on forage inventory	1939-87	89
6215	Interest on operating capital	1910-87	88
6217	Interest on crop inventory and operating capital (sum of 6210-6215)		
6218	Interest on wheat inventory	1939-87	89
6219	Interest on soybean inventory	1939-87	89
6221	Interest added by non-real-estate debt	1939-87	88

Input Number	*Category*	*Years*	*Price deflator code*[2]
6222	Interest on non-real estate-debt at the mortgage interest rate	1939-87	88
6223	Minus one times 6222	1939-87	88
7000	**Miscellaneous inputs**	1870-1900	--
7301	Insurance: Fire and wind	1910-87	14
7305	Insurance: Crop-hail (net)	1910-87	76
7306	Insurance: Federal crop (net)	1939-87	76
7401	Containers	1910-87	64
7403	Binding materials	1910-87	66
7405	Dairy supplies	1910-87	68
7407	Pesticides	1910-87	70
7409	Irrigation operating and maintenance charges	1910-87	72
7411	Sorgo tolls	1910-39	--
7413	Veterinary	1910-87	16
7415	Telephone (farm share)	1910-87	74
7419	Sugarcane syrup tolls	1910-39	--
7421	Ginning charges	1910-87	40
7428	Interest on horse and mule inventory	1910-65	89

--Not applicable.

[1]Revisions from 1979-87 due to 1982 census, and FCRS revisions.

[2]Price index code explained in Appendix III.

Appendix III: Price Deflator Index Number Codes

This appendix defines the price deflator codes used in Appendix II, grouped broadly into prices paid and prices received categories. As noted in Appendix III, some deflators are hybrids of two or more specific price deflators.

Prices Paid

02 Average gross hourly earnings, durable goods manufacturing industries [BLS]
04 Farm wage rates [ASB]
06 Prices paid, interest, taxes and wage rates (parity Index) [ASB]
08 Prices paid (Living & production) [ASB]
10 Production, interest, taxes and wage rates [ASB]
12 Production only [ASB]
14 Building and fencing materials [ASB]
15 Service building construction costs [FSFAB]
16 Farm supplies (farm and motor supplies) [ASB]
18 Motor vehicles [FSFAB]
20 Prices paid for automobiles [FSFAB]
22 Automobiles and automobile supplies [ASB]
24 Motor supplies [ASB]
26 Prices paid for auto repairs and maintenance [BLS]
28 Prices paid for trucks [FSFAB]
30 Prices paid for tractors [FSFAB]
32 Farm machinery [ASB]
34 Gasoline [BLS]
36 Electricity [BLS]
38 Harness and saddling [ASB]
40 Custom work (farm services and cash rents) [ASB]
42 Automobile tires [BLS]
44 Automobile repairs, parts and tires [ITPB]
45 Automobile repairs, parts and tires plus licenses and insurance [ITPB]
46 Truck and bus tires [BLS]
48 Truck repairs, parts and tires [ITPB]
49 Truck repairs, parts, tires, licenses, and insurance [ITPB]
50 Tractor tires [BLS]
51 Tractor and other farm machinery repairs, parts, and tires [ITPB]
52 Tractor repairs, parts and tires [ITPB]
54 Other farm machinery repairs [ITPB]
55 Trucking costs [ITPB]
56 Fertilizer [ASB]
58 Seed [ASB]
60 Feed [ASB]
62 Taxes on farm real estate (taxes payable per acre) [ASB]
63 Purchases of goods and services by state and local governments [BLS]
64 Containers [ASB]
66 Binding materials [ASB]
68 Dairy supplies [ASB]
70 Agricultural chemicals (pesticides) [ASB]
72 Irrigation operation and maintenance [Bureau of Reclamation]
74 Telephones [ASB]

Prices Received

76 Prices received for all crops [ASB]
80 Prices received for all farm products [ASB]
84 Prices received for livestock and livestock products [ASB]

Hybrid Index Numbers

88 Price indexes divided by the mortgage interest rate
88A Index (10) divided by 1976-78 mortgage interest rate
88B Index (32) divided by 1976-78 mortgage interest rate
88C Index (06) divided by 1976-78 mortgage interest rate
88D Index (12) divided by the difference between the short-term interest rate and the mortgage interest rate

89 Weight period prices times the mortgage interest rate (90)

ASB = Agricultural Statistics Board.
BLS = Bureau of Labor Statistics.
FSFAB = Farm Sector Financial Analysis Branch, ERS.
ITPB = Inputs, Technology, and Productivity Branch, ERS.